APPLICATIONS OF ECOLOGICAL (BIOPHYSICAL) LAND CLASSIFICATION IN CANADA

APPLICATIONS DE LA CLASSIFICATION ÉCOLOGIQUE (BIOPHYSIQUE) DU TERRITOIRE AU CANADA

Ecological Land Classification Series, number 7

Série de la classification écologique du territoire, numéro 7

APPLICATIONS OF ECOLOGICAL (BIOPHYSICAL) LAND CLASSIFICATION IN CANADA

APPLICATIONS DE LA CLASSIFICATION ÉCOLOGIQUE (BIOPHYSIQUE) DU TERRITOIRE AU CANADA

Proceedings of the second meeting

CANADA COMMITTEE ON ECOLOGICAL (BIOPHYSICAL) LAND CLASSIFICATION

4-7 April 1978
Victoria, British Columbia

Compte rendu de la deuxième réunion

COMITÉ CANADIEN DE LA CLASSIFICATION ÉCOLOGIQUE DU TERRITOIRE

4-7 avril 1978
Victoria, Colombie-Britannique

Compiled and Edited by / Compilé et Édité par

C. D. A. Rubec

Ecological Land Classification Series, number 7

Série de la classification écologique du territoire, numéro 7

Lands Directorate
Environment Canada

Direction générale des terres
Environnement Canada

March 1979

Mars 1979

Cover: Victoria-Vancouver, British Columbia, 20 July 1974, false colour composite image of LANDSAT II bands 4,5 and 7. Image number 10727-18290. Courtesy of the Canada Centre for Remote Sensing.

Couverture: Victoria-Vancouver, Colombie-Britannique, 20 juillet 1974, une image en couleur simulée composant des bandes 4,5 et 7 de LANDSAT II. Numéro de référence d'image 10727-18290. Avec la gracieuse permission du Centre canadien de télédétection.

Available in Canada through

Authorized Bookstore Agents
and other bookstores

or by mail from

Canadian Government Publishing Centre

Supply and Services Canada

Hull, Quebec, Canada K1A 0S9

Catalogue No. En 73-3/7 Canada: $7.00
ISBN 0-660-50142-2 Other countries: $8.40
Price subject to change without notice.

Friesen Printers
Contract # 0KT8-3543

En vente au Canada par l'entremise de nos

agents libraires agréés
et autres librairies

ou par la poste au:

Centre d'édition du gouvernement du Canada

Approvisionnements et Services Canada

Hull, Québec, Canada K1A 0S9

N° de catalogue En 73-3/7 Canada: $7.00
ISBN 0-660-50142-2 Hors Canada: $8.40
Prix sujet à changement sans avis préalable.

EDITOR'S PREFACE

These proceedings report on the second meeting of the Canada Committee on Ecological Land Classification, held at Victoria, British Columbia April 4-7, 1978. This meeting focussed on the applications of ecological land survey information in Canada.

'Applications' is a comprehensive term referring not only to the actual use of an ecological approach to land survey but, more so, to the interpretation of field data in such disciplines as forestry, hydrology and wildlife. The practical evaluation of ecological information for land planning and management occurs in a wide variety of locations in Canada whether it be for remote wilderness studies or urban development. The papers presented here provide a comprehensive view of the current ecological approach to land survey and information application in this country.

These proceedings are divided into five sections dealing with the business and theme of the meeting. Papers are published in the language of the author's choice (french and english if both versions were submitted) with bilingual abstracts on all papers. I have written abstracts for those papers where none was presented by the author. Sections are headed as follows:

(1) Summary of Business Sessions: A summary is presented of the workshops held at this meeting. These include sessions on the philosophy, cost/benefits and information exchange of ecological land survey as well as discussions of proposed CCELC projects such as ecoregion mapping and an updated *Guidelines* document. Introductory remarks by the CCELC Vice-Chairman lead off the proceedings.

(2) Reports of Chairmen and Workshops: The recent activities of the Methodology/Philosophy and Land/Water Integration Working Groups are outlined as well as a perspective of the entire Committee by the CCELC Chairman. Reports are included on the Workshop on Ecological Land Classification in Urban Areas, sponsored the CCELC and CMHC and held in Toronto in November 1976; and a Symposium on Ecological Forest Land Evaluation, sponsored by the Canadian Institute of Forestry, and held in Vancouver in September 1977.

(3,4) Reports: In these sections, reports by representatives to the CCELC from provincial and federal agencies, provide an overview of the current status of ecological land survey in government departments in Canada.

PRÉFACE DE L'ÉDITEUR

Voici le compte rendu de la seconde réunion du du Comité canadien de la classification écologique du territoire, qui s'est tenue à Victoria en Colombie-Britannique, du 4 au 7 avril 1978. Cette réunion a été centrée sur les applications des renseignements obtenus par suite de relevés écologiques du territoire, au Canada.

Le mot 'application' a ici une notion globale qui non seulement comprend une approche écologique au relevé du territoire, mais, peut-être encore plus, l'interprétation des données recueillies sur le terrain dans des disciplines comme la foresterie, l'hydrologie et l'étude de la faune. L'évaluation pratique des données écologiques en vue de la planification et de la gestion applicables aux terres se fait pour un grand nombre d'endroits au Canada, que ce soit pour des lieux déserts éloignés ou des centres urbains. Les documents présentés ici donnent un exposé complet sur l'actuelle approche écologique au relevé du territoire et à l'application des renseignements recueillis dans ce pays.

Le présent compte rendu est divisé en cinq sections groupant les points discutés à la réunion. Les rapports sont publiés dans la langue choisie par l'auteur, en français et en anglais si les deux versions ont été déposées, et accompagnées d'un résumé bilingue. J'ai fait les résumés des rapports qui n'en comportaient point.

Le compte rendu se divise comme suit:

1) Sommaire des sessions: Il s'agit d'un sommaire des ateliers tenus à cette réunion. Il comprend les sessions sur les principes, sur les coûts et les avantages, sur les échanges de renseignements tirés de relevés écologiques du territoire aussi bien que les discussions sur les projets du CCCET, telles la cartographie des écorégions et la mise à jour des lignes directrices. Il comprend aussi l'introduction faite par le vice-président du CCCET.

2) Rapports des présidents et rapports sur les ateliers: Les travaux récents du Groupe de travail sur les méthodes et les principes et du Groupe de travail sur l'intégration terres/eau y sont décrits; on y retrouve aussi un exposé sur les perspectives du Comité par le président du CCCET. Cette section renferme le rapport sur les travaux de l'atelier sur la classification écologique du territoire en les régions urbaines, parrainé par le CCCET et par la SCHL, qui s'est tenu à Toronto en novembre 1976, ainsi que le rapport sur le symposium pour l'évaluation écologique

(5) Background Papers: Leading off this section is a user profile of Ecological Land Classification (ELC) applications identified by a questionnaire which we distributed to Canadian agencies. The CCELC Secretariat then invited numerous papers from government agencies, consulting firms, industry and universities in Canada to provide background documentation for the discussions at this meeting. These papers identify many of the users of ELC information; outline the benefits, problems and costs associated with ELC data interpretations; and discuss topics such as the scales, and information presentations considered optimal for practical use of ELC information.

We hope the papers in these proceedings provide an understanding of the state of the art of ecological land survey in Canada as well as providing documentation of practical user applications of the survey data. In addition, we hope these papers will be of assistance in the preparation of comprehensive classification guidelines for ELC. The interest and participation of specialists in this nation as well as our international colleagues has been most gratifying and welcomed. With these proceedings we hope the process of information exchange and thoughtful discussion will be enhanced.

des forêts, parrainé par l'Institut forestier du Canada et qui a eu lieu à Vancouver en septembre 1977.

3,4) Rapports: Dans ces sections, les rapports des représentants des organismes provinciaux et fédéraux au CCCET, donnent une vue d'ensemble de l'état actuel des relevés écologiques du territoire faits par les ministères, au Canada.

5) Documents de base: Au début de cette section, on présente le profil des applications des relevés écologiques du territoire, mises en lumière à l'aide d'un questionnaire que nous avions distribué aux organismes canadiens. Le secrétariat du CCCET avait demandé à de nombreux organismes du gouvernement, firmes d'experts-conseils, industries et universités du Canada de présenter des documents qui serviraient de base aux discussions à la réunion. Ces documents identifient nombre d'utilisateurs des renseignements obtenus par les relevés écologiques du territoire; ils indiquent les avantages, les problèmes et les coûts associés à l'interprétation des données écologiques sur les terres; ils analysent des questions, comme les échelles de mesure; et donnent les renseignements considérés comme les meilleurs pour une utilisation pratique de l'information écologique sur les terres.

Nous espérons que les documents suivants aideront à la compréhension de l'état des relevés écologiques du territoire au Canada et qu'ils fourniront des renseignements d'ordre pratique sur l'utilisation des données. De plus, nous espérons que ces documents aideront à la préparation de lignes directrices complètes pour la classification des relevés écologiques du territoire. L'intérêt et la participation des spécialistes de ce pays, comme ceux de nos collègues des autres pays, ont été des plus agréables, et nous les en remercions. Nous espérons que ce compte rendu favorisera les analyses et les échanges de renseignements.

CONTENTS/MATIÈRES

REPORTS OF CHAIRMEN AND WORKSHOPS
RAPPORTS DES PRÉSIDENTS ET DES ATELIERS

REPORTS BY PROVINCIAL REPRESENTATIVES
RAPPORTS DES REPRÉSENTANTS DES PROVINCES

REPORTS BY REPRESENTATIVES OF FEDERAL AGENCIES
RAPPORTS DES REPRÉSENTANTS DES AGENCES FÉDÉRALES

BACKGROUND PAPERS ON APPLICATIONS OF ECOLOGICAL LAND CLASSIFICATION IN CANADA
ÉTUDES DE FOND SUR LES APPLICATIONS DE LA CLASSIFICATION ÉCOLOGIQUES DU TERRITOIRE AU CANADA

APPENDICES

OPENING REMARKS SECOND MEETING, VICTORIA

A. N. Boydell
Ministry of the Environment
Resource Analysis Branch
Victoria, British Columbia

First, I should like to extend a warm welcome to you all on behalf of the Canada Committee on Ecological Land Classification and the Province of British Columbia.

It is almost four years to the day since the Toronto workshop on Canada's Northlands which focussed our concerns on a strategy leading to the formation of the CCELC and brought it, via the first meeting of the Committee in Petawawa and the Urban Ecological Land Classification Workshop in Toronto, to this meeting today. The latter stages of this progression will, I am sure, be more fully described in the reports of the Working Group Chairmen and the Provincial Representatives.

During these four years, in British Columbia, we have witnessed a marked shift in demand away from the regional emphasis of the British Columbia Land Inventory, to the more local, almost site-specific requirements of our resource management agencies. Moreover, the need for regional inventory has not been satisfied and our long range objectives must still include the creation of an adequate provincial resources data base. But in large measure, our priorities lie more and more in serving the complex demands of the environmental impact assessment process, regional and municipal planning or the management of small parcels of forested land.

Shifting demands seem to require almost a wholesale examination of our basic concepts and philosophies. This workshop with its applications theme will, I hope, provide the mechanisms to begin just such an examination.

Once again, welcome to Victoria. I think you will find the next few days of meetings interesting and rewarding.

ALLOCUTION D'OUVERTURE, DEUXIÈME RÉUNION,VICTORIA

A. N. Boydell
Ministère de l'environnement
Direction de l'analyse des ressources
Victoria, Colombie-Britannique

Permettez-moi d'abord de vous souhaiter la bienvenue au nom du Comité canadien de la classification écologique du territoire et au nom de la province de Colombie-Britannique.

Il y presque quatre ans, jour pour jour, se réunissait l'atelier de travail de Toronto sur les terres du Nord, afin de discuter d'une stratégie qui entraîna la création du CCCET et par l'entremise de la première réunion à Petawawa et de l'atelier de travail de Toronto sur la classification écologique de territoire urbain cela a mené à la présente réunion. Les dernières étapes de cette progression seront, je l'espère, mieux décrites dans les rapports des représentants provinciaux et du président du groupe de travail.

Au cours de ces quatre années, la Colombie-Britannique a été témoin d'un bouleversement de la demance, qui s'éloignait de plus en plus du contexte purement régional (Inventaire du territoire) pour viser des objectifs locaux de nos organismes de gestion des ressources. Qui plus est, nous n'avons pas encore répondu aux besoins d'établir un inventaire des régions, et nos objectifs à long terme doivent comprendre la création d'une base adéquate de données sur les ressources de la province. En règle générale, toutefois, nos priorités consistent de plus en plus à satisfaire les demandes complexes du processus d'évaluation des incidences environnementales, de la planification régionale et municipale et de la gestion de petites parcelles des terres boisées.

Cette nouvelle orientation de la demande exige presque que l'on examine entièrement nos concepts fondamentaux. Le présent atelier de travail fournira, je l'espère, les outils pour entreprendre un tel examen.

Encore une fois, je vous souhaite la bienvenue à Victoria et une réunion des plus enrichissantes.

Tony Boydell

SUMMARY OF BUSINESS SESSIONS AND WORKSHOPS

D. M. Welch, E. B. Wiken and D. G. Taylor
Lands Directorate, Environment Canada
Ottawa, Ontario

INTRODUCTION

The second national meeting of the Canada Committee on Ecological Land Classification was convened in Victoria, B.C. April 4, 1978. In his opening remarks, Tony Boydell noted that in British Columbia there has been a shift from regional environmental surveys to a need for site specific data. Priorities have shifted to local environmental impact studies, municipal and regional planning and studies of forest subunits. He expressed the hope that this CCELC meeting, with its applications theme, could adapt the philosophy and methodology of ecological land survey (ELS) to cope with these new requirements.

The chairman of the CCELC, Jean Thie, then proceeded with his report to the committee members. He elaborated on the applications theme of the meeting by outlining three areas of concern which the committee should keep in mind during its workshop sessions:
a) what should the CCELC be doing now and over the next few years,
b) how effective is the committee,
c) how can the committee involve the maximum number of individuals without becoming unwieldy and thus ineffective.

He went on to outline specific questions to be dealt with in the various workshops during the course of the meeting. These included the second approximation to the ELS guidelines, a consideration of the feasibility of producing an ecoregion (and ecodistrict) map of Canada, and the need for workshops on vegetation and remote sensing as applied to ELS. He also asked if another national meeting was required within the next two years and raised the question of rotation of the chairmanship as the term of his appointment was drawing to a close. To deal with this, he enlisted several members of the committee to draw up recommendations for regulating the chairmanship of the CCELC. This ad hoc committee consisted of R. Fulton, A. Appleby, P. Rennick, and J. Thie. Reports of the CCELC working groups and the provincial CCELC representatives were tabled and are included in the text of these proceedings.

Initiated by Pat Duffy, the subsequent discussion centered around integration or lack of it in contemporary ELS studies. Some participants indicated that they were uncertain as to what an integrated survey was and how to achieve it. It was suggested the present ELS stops short at environmental descriptions and a large amount of the data collected is not analyzed and correlated. Part of the problem was considered to be the lack of training in integrated approaches to environmental studies in the educational system.

The Canada Land Data System (CLDS) ecological data base display was demonstrated by Nicole Chartrand in the afternoon and workshop sessions were convened. These were broken into two categories, (A) CCELC Business and (B) Applications Theme workshops. The latter were held the second day in the afternoon following presentation of invited papers in a technical workshop. Those papers are also included in the text of this volume. A summary of the discussions and recommendations of the various workshops follows. Final recommendations and discussion presented during an overall business session on the last day are also outlined.

WORKSHOP SUMMARIES

1. Methodology/Philosophy Workshops:

Participants:

(A)	(B)
S. Rowe - Chairman	S. Rowe
A. Boissonneau	P. Gimbarzevsky
C. Tarnocai	W. Holland
B. Findlay	B. Fulton
M. Walmsley	T. Friend
J. van Barneveld	T. Chamberlin
S. Zoltai	T. Lord
V. Gerardin	S. Nikleva
H. Kimmins	J. Ducruc
R. Lang	D. Cowell
E. Wiken	T. Vold
G. Gagnon	

The methodology/philosophy workshops discussions centred upon the following ideas and recommendations. A working paper by Stan Rowe is also presented in these proceedings.

- 'Ecological' land classification, in contrast to single discipline classifications, is concerned with the interactions of components (e.g. soils, landforms, vegetation, wildlife, etc.) which indicate environmentally significant boundaries when and where these components covary.

- The actions of classification and mapping must be kept separate, classification being a method used to define and delineate ecologically significant units of land.

- Taxomonic and mapping units are distinct. Taxonomic units are considered explanatory while mapping units are often necessarily composites of such units.

- Functional units of land (e.g. drainage basins, airsheds, habitat clines) should be stressed.

- The approach to and methodology of ELC must be made more rigorous. Proceedures should be explicit and standardized. Initial assumptions must be clearly stated. Validation by repeatability should be considered by users. Such validation is dependent on the logic and the explicitness of the methodology used.

2. Land/Water Integration Workshop:

Participants: N. Loupoukhine - Chairman
G. McCullough
G. Mills
B. Fulton
T. Chamberlin
J. Ducruc
D. Welch
S. Nikleva
G. Padbury
W. Holland

The activities of the Land/Water Integration Working Group since the last CCELC meeting are summarized in Nick Lopoukhine's report which is included in the text of the proceedings. The workshop group approved, with minor modifications, a questionnaire designed to assess the needs of those interested in land/water integration and classification. The proposal to have a land/water workshop was set aside until a clear need could be demonstrated, perhaps as a result of the response to the questionnaire. The group felt that land/water integration was at a stage where it could profit by a small group of practitioners meeting to draft a first approximation to land/water classification guidelines. It was generally agreed that the Wetlands Working Group should participate in any such discussions. Finally, it was concluded that the chairmanship of the group should be changed with Jean-Pierre Ducruc assuming the position from Nick Lopoukhine.

3. Wetlands Workshop:

Participants:

F. Pollett - Chairman	S. Edlund
A. Boydell	K. East
P. Gimbarzevsky	H. Rostad
G. Wickware	T. Vold
J. Levasseur	B. Hart
	E. Kenk

The topics of discussion of the workshop are given in Fred Pollett's paper included in these proceedings. Briefly summarized these topics include:

- Production of a 'high quality' book on Canada's wetlands aimed at a high school and freshman university audience.

- Organization of a Canadian symposium on wetlands for the early 1980's possibly at the University of Manitoba.

- Preparation of a wetland classification system for Canada to be presented at the planned national symposium.

- Establishment of a central registry of wetland types. Charles Tarnocai agreed to pursue this and the possibility of computerizing such a registry.

- Annual workshops on wetlands were proposed and accepted.

- A need for a questionnaire to be circulated to identify parties interested in having an input into the working group's activities.

4. CCELC Organizational Workshop:

Participants: J. Thie - Chairman
J. Prokopchuk
A. Appleby
D. Bates
G. Marcotte
P. Duffy
M. Barnett
T. Friend
E. Macintosh
W. Eedy
P. Denison

The organizational workshop addressed three questions - the priorization of future CCELC activities, the fate of the Data Handling Working Group, and the problem of achieving

effective participation in CCELC activities by all interested parties.

a) Priorization of Future Activities:

The workshop consideration of establishment of short (1 to 2 week) courses on how to use ELC products was a primary priority. Such courses should be offered locally or regionally.

The second approximation of the ELS guidelines and the ecoregion mapping of Canada were the next most important goals to be achieved. The guidelines should not become bound up in taxonomy and, although national in perspective, should reflect regional variation. The ecoregion map was considered an important educational tool as well as providing a national land resource perspective. The question of a national symposium was considered best deferred until the completion of the second approximation to the guidelines and the ecoregion map of Canada. More pressing was the need for workshops on wildlife, how to do ecological land surveys and finally the need for a remote sensing workshop was identified.

b) Fate of the Data Handling Working Group:

The problem of the data handling working group was discussed and considered to be an important area of activity which should be continued.

c) Achievement of Effective Participation:

The present approach using working groups was considered satisfactory. Newsletters, proceedings, discussion papers, and symposia were also acceptable; however the idea of local workshops should be given more emphasis.

5. <u>Information Exchange Workshop:</u>

Participants:	<u>P. Glaude</u>	P. Rennick
	K. Seel	W. Harris
	P. Normandeau	N. van Waas
	H. Luttmerding	D. Moon
	A. Kerr	D. Cowell

The workshop members concluded that the goals of exchange of technical information and communication with the general public and various interested organizations have not been as successful as hoped for. Also the time for publication and distribution of CCELC information has been too slow and the prime users have yet to be identified.

The workshop formulated the following list of recommendations on information exchange. Furthermore the consensus was that a new working group need not be formed to deal with the problem as information exchange should naturally be the concern of all committee members and at least one member should be assigned as a watchdog to maintain a viable information exchange program.

- symposia should be continued, but on a regional basis, involving all interested participants, whether public, private industry, institutions or governments, using topics with applications to any specific region;

- develop and publish a CCELC Journal to report on technical matters, studies, reviews, summaries, etc;

- develop and publish a numbered "special report" series;

- develop and promote ELS courses for academic application (High Schools, Universities, Post-Grad Planning Schools, etc.);

- prepare and make available annotated bibliographies for use by schools, libraries, public, etc.;

- promote ELS-related hardware system application, to show the value and flexibility of ELS data;

- prepare and distribute a CCELC information pamphlet for general consumption, but related to specific audiences, projects, problems using an illustrated approach, (e.g. forest talk);

- sponsor a public lecture series;

- make use of community cable T.V.;

- utilize interested, existing organizations and community structures (e.g. Sierra Club, Ontario Federation of Naturalists, etc.);

- encourage ELS field staff to carry their special knowledge about a project to the actual user;

- ELS personnel must clearly identify the intent, value and limitations of the biophysical data presented, and furthermore clarify the value and application limits of subsequent base maps;

- use the past experience gained by the CCELC

as a means to demonstrate to potential users, and the public at large, the evolution ELS has undergone. Use the CLI as an example of a workable system;

- develop and promote a vehicle that will inform and teach resource managers, specialists, contractors, politicians and the public in the ways of application, feasibility, methodology, benefits and costs of ELS, and prepare general information packets for such people;

- the CCELC must demonstrate to governments and the public that it has public application, value and benefits.

6. Workshops on Guidelines for ELS:

Participants:

Workshop A	Workshop B
P. Duffy	D. Welch
R. Lang	C. Tarnocai
D. Bates	A. Appleby
K. East	E. Macintosh
W. Eedy	P. Denison
P. Normandeau	M. Barnett
P. Rennick	N. Lopoukhine
H. Luttmerding	M. Walmsley
A. Kerr	G. Gagnon
P. Glaude	J. Prokopchuck
	G. Mills
	D. Moon
	A. Boydell

Two groups of committee members were asked to discuss the need for, format, and production of a second approximation to ELS guidelines. Both groups differed in their recommendations on this matter.

Group A chaired by Pat Duffy, identified an immediate need for revised guidelines. The group concluded that the guidelines should be brief enough for easy use and special sections (e.g. limitations and applications, land/water integration, cost-benefit analysis, vegetation classification, and wetlands) be appended in additional volume(s). Furthermore the guidelines must follow specific recommendations of the CCELC working groups, allow for regional variation in approach, and show an improvement in the explanation of ELS principles. The new guidelines should be written on the basis of the 1969 guidelines with modifications stemmed from recent ELS experiences. Both the philosophy and terminology of ELS were found in need of clarification. Finally emphasis on the integration of data was considered critical.

The production of these guidelines should involve some of the original guidelines group, the majority of ELS practitioners, government/university/industry representatives and some theorist and cost-control input. In addition, the guidelines must have an application orientation and, therefore, have input from potential users. Funding for this project should come from federal sources.

Group B, chaired by David Welch, however concluded that detailed guidelines would not likely achieve an early consensus and would not be universally accepted. Thus, various projects would still follow their own approach and methodology. As in the other group the consensus indicated that this regional variation should not be eliminated. It was also pointed out that unduly detailed data on one aspect of ELS (e.g. soil) was often not understood by users. Thus, the guidelines should emphasize interpretation and generalization of data with the user in mind. The workshop recommended that the guidelines be modified from "Guidelines For Classification" to "Examples of Various Approaches", that interpretations and applications be emphasized, and that explicit descriptions of methodology be emphasized.

With reference to format the group suggested the following:

1) A statement on philosophy (c.f. CCELC Working Group on Methodology/Philosophy)
2) Outline of data required (e.g. for the Environmental Assessment Review Panel)
3) Reference to extant classification systems (e.g. soil, terrain)
4) Guidelines for classifying water, vegetation, wildlife, and socioeconomic data.
5) Examples of actual projects
6) Guidelines for interpretations and applications

Finally the group suggested that production of the guidelines be given to the CCELC Secretariat and the authors be the CCELC Working Groups.

7. Ecoregions Workshop:

Participants:

S. Zoltai	B. Findlay
A. Boissonneau	G. Gagnon
E. Wiken	N. van Waas
K. Seel	G. Padbury
G. Wickware	E. Kenk
	F. Pollett

The workshop consensus was that production of an ecoregion map by the CCELC should be given

high priority. There was considerable debate on the definition of an ecoregion with little agreement and on the scale of mapping that should be employed. It was recommended that the methodology/philosophy working group be given the task of preparing definitions of an ecoregion and an ecodistrict. A scale of 1:1,000,000 was suggested. The information that could be derived from such a map was also hotly debated and it was contended that the map must answer to the needs of its users and not vice-versa.

It was agreed that the CCELC was the sole forum capable of producing such a map and that the format might well be comparable to that of recent studies of the Yukon and Labrador but with greater emphasis on the relationships of ecological components. Finally, it was considered that any attempt at predicting the cost of such a project is premature and that the CCELC should consider the formation of an Ecoregion Working Group to undertake the task.

8. Vegetation Workshop:

Participants: V. Gerardin
J. van Barneveld
S. Edlund
W. Harris
G. Marcotte
J. Levasseur
W. Bourgeois

The members of the vegetation workshop discussed the feasibility of establishing a common basis for vegetation analysis across Canada. They were skeptical of this idea due to the variability in vegetation across the country and pointed out that their problems were highly specific. It was felt by some that there is no need to establish a vegetation working group within the CCELC at the current time.

9. Ecological Land Use Planning Workshop:

Participants: K. East, D. Luff, T. Boydell, J. Crosby-Diewold, R. Lang, E. Wiken, P. Rennick, S. Rowe, P. Glaude, H. Slavinski, T. Friend, A. Appleby, D. Cowell, F. Pollett

The group felt there is a need for planning for human use with a maximum of environmental consideration. Furthermore, land use planning in the foreseeable future will be a dominantly socioeconomic activity with planning objectives determining the degree of environmental influence on decision making.

Several recommendations which might assist in moving towards ecologically or environmentally appropriate planning were suggested:

- Continuation of regional survey programs to provide a broad data base for enlightened regional planning as a precursor to area planning, the cumulative effects of which might be undesirable.

- Attention to the issue of "value systems" in decision making to ensure that greater ecological awareness becomes part of it

- Development of a series of environmental indicators which, hopefully, might play a greater role in national and provincial policy making and direction setting.

- Establishment of an independent Environmental or Ecological Council of Canada or of the Provinces to monitor the state of the environment and issue annual status reports.

10. Information Presentation and Communication Workshop:

Participants: M. Barnett, D. Bates, N. van Waas, J. van Barneveld, G. Padbury, V. Gerardin, S. Nikleva, E. Macintosh, G. McCullough, H. Luttmerding, W. Harris, R. Fulton, W. Bourgeois, G. Gagnon, S. Lamont

The workshop concluded that there is a 'communication' gap between the ELS data base and its users. Some of the reasons for this gap were considered to be delays in the delivery of data to the user and the volume and complexity of the data with which the user is presented. Resolution of the problems posed some difficulty. Means suggested to reduce this gap in understanding between ELS producers and users included providing the user access to the ELS data bank; discussions between the mapper and user to aid in mutual understanding; avoidance of jargon; and simplification of data presentation (e.g. map alphanumerics). The limitations of the mapping scale must also be emphasized to users; that is, they must be made aware of the variance in map accuracy at different scales. The group felt the CCELC's role should be to organize user workshops to achieve a better understanding between producers and users of ELS data.

11. Cost-Benefit Workshop:

Participants: W. Eedy - Chairman

P. Duffy	J. Levasseur
J. Ducruc	G. Wickware
S. Zoltai	H. Rostad
P. Normandeau	D. Welch
A. Kerr	L. van Vliet
J. Prokopchuck	G. Mills
	N. Lopoukhine

The purpose of the Cost-Benefit Workshop was to examine the ELS data base and the advantages and disadvantages of the ELS approach in contrast to conventional surveys from a cost-benefit view point. The workshop developed the following list of advantages and disadvantages for the ELS approach:

(a) Adv. - Integrated data is flexible and provides a common framework.

Disadv. - The data base is too flexible and possibly causes submergence of single disciplines.

(b) Adv. - Common mapping scales and boundaries make data easier and cheaper to store.

Disadv. - User training is required to enable use of such data.

(c) Adv. - An economical use of resources in the field occurs and allows stratification of sampling.

Disadv. - The survey team may not be workable in the field, some disciplines work at different rates and have seasonality components governing data collection.

(d) Adv. - It is more economical to produce one map base for integrated data presentation.

Disadv. - One map base can result in highly complex data presentations.

(e) Adv. - It is durable over time as stable environmental components are depicted, except ...

Disadv. - At detailed scales where boundaries and map units are not necessarily durable over time.

(f) Adv. - The ELS rational is easy to sell to administrators.

Disadv. - Too much data can be generated while expenditure and resource allocation to participants must be controlled.

(g) Overall, ELS allows planning in a holistic framework of the environment and gives ecological value from a dynamic or process viewpoint.

The workshop considered that the cost-benefit ratio in ELC projects might be improved by having one person in charge of the ELS team and allocation of resources; understanding user needs concerning scale and data requirements; and exploitation of existing data to avoid duplication of effort.

The role of the CCELC in demonstrating the cost-benefit aspects of current ELS projects should involve selling the ecological benefits of ELS; engaging in explanation of the ELS approach in laymans terms; and circulation of detailed questionnaires to project leaders concerning costs and estimates of costs of doing the same study using the single discipline approach.

In terms of cost breakdown, the workshop indicated that the majority of money and time should be invested in preparation, data collection, and data analysis and that presentation of data be allocated 20-25% of the budget. Time as well as financial costs should be considered in planning ELS and giving cost estimates.

Finally, follow-up of cost-benefit analysis should involve an assessment of the predictive value of ELS and the monitoring of user satisfaction and user scrutiny of ELS with respect to the applicability of the data.

12. Interpretation Guidelines Workshop:

Participants:		
	W. Holland	B. Hart
	S. Edlund	J. Thie
	P. Duffy	R. Travers
	C. Tarnocai	G. Mills
	K. Seel	D. Moon
	J. Prokopchuck	E. Kenk
	B. Findlay	T. Chamberlin
	J. Crosby-Diewold	

This workshop discussed the need for interpretation guidelines to communicate ELS work to other organizations and the public. The group recommended the establishment of a formal CCELC committee to investigate the problem and to attempt a pilot project using data from a specific ecological land survey.

FINAL BUSINESS SESSION

CCELC Chairmanship

Beginning this session Bob Fulton reported the findings of the ad hoc committee struck by Jean Thie to develop recommendations governing the CCELC chairmanship. Recommendations were submitted as follows:

a) that the principle of the rotation of the chairmanship among government and non-government organizations and regions be maintained.

b) that the Lands Directorate should be asked to provide an executive director for the CCELC. The duties of the executive director should be such that he will play a very significant role in running the CCELC. The chairman should function more in the field of general policy direction (i.e. the executive director will be analogous to a Deputy Minister and the chairman a Minister).

c) that J. Thie should be asked to act as chairman for one more year while the position of executive director is organized and filled.

d) that a search committee for a new chairman be struck composed of the executive director, the present chairman and working group chairman. Candidates names should be submitted to this committee for discussion.

Summary and Discussion of Workshops

David Welch and Ed Wiken, on behalf of the CCELC Secretariat, analyzed the reports of all the workshops, and prepared for the final business session a summary for discussion by the full Committee.

Many of the workshop recommendations were in the nature of suggestions to Working Groups, the Secretariat, project leaders and individuals, as to how to standardize their methods, and how to develop the wider application of Ecological Land Survey. For this final business session, however, only those recommendations related to CCELC activities have been brought forward. This was done because the Secretariat perceived from many comments, suggestions and discussions during the meeting, that the time for large, general purpose meetings was past, and that in future the CCELC should focus on specific tasks, namely various publications and technical level meetings. From this future the CCELC should focus on specific tasks, namely various publications and technical level meetings. From this perspective was drawn up the following list of recommendations.

Recommendations Related to Working Groups

a) Methodology/Philosophy:

- the M/P working group should concentrate on defining terms, especially of ecoregions and ecodistricts,

- the M/P working group should first establish the basic philosophy and cost-benefit rationale leaving the more controversial subjects (e.g. methodology, taxonomy) until later.

b) Land/Water Integration:

- there is no need for an immediate national workshop,

- the L/W working group should be oriented into small activity groups at the technical level (such as sessions with air photos),

- development of guidelines should commence,

- increased consultation between working groups is needed,

- chairmanship of the working group will change to Jean-Pierre Ducruc.

c) Wetlands:

- a major project is a National Wetlands book produced with regional input by 1981 under the direction of Fred Pollett,

- a Wetlands Registry is to be established under the direction of Charles Tarnocai,

- annual workshops and field trips are to continue,

- a mailing list questionnaire is to be developed.

d) Data Handling:

- there were no recommendations from this group but the CCELC Organization Workshop emphasized its importance and recommended that

this working group be activated.

e) Proposed Working Groups:

- there being no consensus as to the feasibility of a vegetation working group it was recommended none be established at this time.

f) Interpretation:

- A need for such a group was identified to develop guidelines for the interpretation of ELS data. These guidelines could be presented by publication of individual project applications or by inclusion in the ELS guidelines.

g) Ecoregions:

- There was a general consensus on the need for a national ecoregion mapping project. Such a project should be steered by a new working group in consultation with the others as regards definitions. Funding for this project would have to be obtained.

Many of the above summary recommendations were adopted without debate. On several points, however, discussion was lengthy arriving at various consensi.

CCELC Organization

- There needs to be more cross-linkage between Working Groups. In some cases this could be achieved by cross-membership; more generally it might be by greater exchange of correspondence and reports.

- The Applications Working Group should have responsibility for developing guidelines on interpretation of ecological land data. In this context, "Application" means the use, interpretation or evaluation of the data, not the application of ecological land classification methods to land survey.

Guidelines

- There was a general agreement as to the need to update the existing guidelines, to recognize the variability of ecological land classification across the country, and to focus especially on the national justification (or benefits) of ecological land surveys.

- The guidelines should include standard terms, sections on content of surveys, mapping scales, methods of interpretation, etc., and a carefully selected set of example projects, taking into account the diverging environment, expertise and purpose of the example survey.

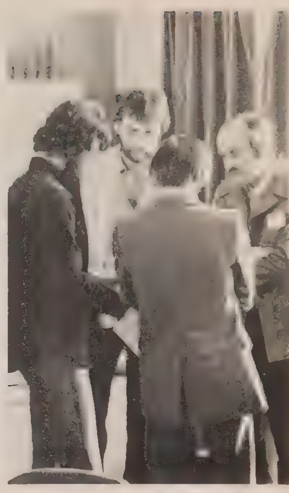
- The CCELC Secretariat should have prime responsibility for producing the Guidelines, although any volunteer contributions should be welcomed. The Guidelines should get feedback from the Working Groups and their Chairmen, and finally be approved by the CCELC.

- Publication could be incremental as each component is available.

* * * * *

After this discussion had run its course Jean Thie thanked both Tony Boydell and Clay Rubec for organizing and making the conference run smoothly. Special thanks was given to Clay Rubec who, apart from organizational tasks, also gathered and prepared for distribution at the meeting the many background papers written by the participants.

On this note Jean Thie adjourned the meeting.



SOMMAIRE DES SESSIONS D'AFFAIRES ET DES ATELIERS

D. M. Welch, E. B. Wiken et D. G. Taylor
Direction générale des terres
Environnement Canada
Ottawa, Ontario

INTRODUCTION

La deuxième réunion nationale du Comité canadien de la classification écologique du territoire a été convoquée à Victoria (Colombie-Britannique), le 4 avril 1978. Dans son exposé d'ouverture, Tony Boydell rapporte que, en Colombie-Britannique, la nécessité de données propres aux sites tend à supplanter les études environnementales des régions. L'accent s'est maintenant porté sur les études des incidences environnementales locales, la planification municipale et régionale et les études des sous-unités forestières. Il souhaite que la présente réunion du CCCET, qui se déroule sous le thème de l'application, trouve le moyen d'exploiter les concepts et la méthodologie des relevés écologiques des territoire (RET) pour faire face à ces nouvelles exigences.

Le président du CCCET, Jean Thie, présente ensuite son rapport du Comité. Il aborde le thème de la réunion en mentionnant trois questions d'intérêt dont le Comité devrait tenir compte lors de ses sessions d'atelier:
a) qu'est-ce que le CCCET doit faire maintenant et au cours des prochaines années?
b) dans quelle mesure le Comité est-il efficace?
c) de quelle façon le Comité peut-il engager un maximum de personnes sans devenir trop lourd et par conséquent inefficace?

Il indique ensuite les questions qui seront abordées dans les divers ateliers de travail qui se tiendront durant la réunion, notamment la deuxième mise au point des lignes directrices du RET, une étude des possibilités de produire une carte des régions (et des districts) écologiques du Canada, ainsi que la nécessité de tenir des ateliers de travail sur la végétation et sur la télédétection, dans leur application au RET. Il demande s'il conviendra de tenir une autre réunion nationale dans les deux prochaines années, et, comme son mandat tire à sa fin, il aborde la question de la succession à la présidence. A cet égard, il désigne plusieurs membres du Comité qui auront pour tâche de rédiger des recommandations visant à régler la succession à la présidence du CCCET. Ce comité spécial est composé de R. Fulton, A. Appleby, P. Rennick et J. Thie. Les rapports des groupes de travail et des représentants provinciaux du CCCET sont déposés et figurent dans le présent compte rendu.

Engagée par Pat Duffy, la discussion suivante est axée sur l'intégration ou le manque d'intégration dans les études récentes du RET. Certains participants disent ne pas savoir au juste ce qu'est un relevé intégré ni de quelle façon l'effectuer. On émet l'avis que l'actuel RET se borne aux descriptions de l'environnement et qu'un grand nombre des données recueillies ne sont pas analysées ni mises en corrélation. On impute une partie du problème au système d'enseignement qui néglige l'apprentissage des approches intégrées à l'étude de l'environnement.

Durant l'après-midi, Nicole Chartrand présente un exposé de la base des données écologiques du Système canadien des données sur les terres (SCDT) et des ateliers de travail sont constitués. Ces ateliers sont divisés en deux catégories: (A) les ateliers consacrés aux activités du CCCET et (B) les ateliers consacrés aux applications. Ces derniers se tiennent durant l'après-midi du deuxième jour après des exposés faits par des conférenciers invités lors d'un atelier technique. Ces documents figurent également dans le présent texte et sont suivis d'un résumé des discussions et des recommandations qui ont marqué les différents ateliers de travail ainsi que la séance générale sur les activités qui s'est tenue le dernier jour.

SOMMAIRES DES ATELIERS

Ateliers de travail sur la méthodologie et la philosophie

Participants:

(A)	(B)
S. Rowe - Président	S. Rowe
A. Boissonneau	P. Gimbarzevky
C. Tarnocai	W. Holland
B. Findlay	B. Fulton
M. Walmsley	T. Friend
J. van Barneveld	T. Chamberlin
S. Zoltai	T. Lord
V. Gerardin	S. Nikleva

H. Kimmins
R. Lang
E. Wiken
G. Gagnon
J. Ducruc
D. Cowell
T. Vold

Les discussions des ateliers de travail sur la méthodologie et la philosophie étaient axées sur les idées et les recommandations ci-dessous. Le présent compte rendu contient également un document de travail rédigé par Stan Rowe.

- Contrairement aux classifications des disciplines isolées, la classification écologique du territoire porte sur les interactions des éléments constituants (sols, relief, végétation, faune, etc.) qui laissent apparaître des frontières écologiques importantes là où et lorsque ces éléments varient ensemble.

- Il ne faut pas confondre la classification et la cartographie: la classification est une méthode qui sert à définir et à décrire les unités territoriales significatives du point de vue écologique.

- Il y a une différence entre les unités de taxonomie et de cartographie. Les unités de taxonomie sont des unités explicatives qui doivent souvent entrer dans la composition des unités de cartographie.

- Il convient de mettre l'accent sur les unités fonctionnelles du territoire (les bassins hydrologiques, les secteurs atmosphériques, les clines écologiques).

- Il convient d'apporter plus de rigueur à l'approche et à la méthodologie de la CET. Les procédures doivent être explicites et normalisées. La répétabilité des résultats peut être validée par les usagers eux-mêmes. Ce mode de vérification repose sur la logique et sur la précision de la méthodologie adoptée.

2. Atelier de travail sur l'intégration terre/eau.

Participants: N. Lopoukhine - Président
G. McCullough
G. Mills
R. Fulton
T. Chamberlin
J. Ducruc
D. Welch
S. Nikleva

Les activités du groupe de travail Intégration terre/eau depuis la dernière réunion du CCCET sont résumées dans le rapport de Nick Lopoukhine qui figure dans le texte du compte rendu. Le groupe de travail approuve, à quelques petites modifications près, un questionnaire conçu pour évaluer les besoins des personnes qui s'intéressent à la classification et à l'intégration terre/eau. On rejette la proposition d'organiser un atelier sur les terres et les eaux jusqu'à ce que la nécessité en soit clairement établie, peut-être par suite des réponses aux questionnaires. Le groupe estime que l'intégration terre/eau est à un stade où elle pourrait tirer profit des travaux d'un petit groupe de spécialistes qui se réuniraient pour formuler une première ébauche des lignes directrices visant la classification terre/eau. On est généralement d'accord pour que le groupe de travail Terres humides participe à ce genre de discussions. Pour conclure, on estime que Jean-Pierre Ducruc devrait succéder à Nick Lopoukhine au poste de président du groupe.

3. Atelier de travail sur les terres humides

Participants: F. Pollett - Président
A. Boydell
P. Gimberzevsky
G. Wickware
J. Levasseur
S. Edlund
K. East
H. Rostad
T. Vold
R. Hart
E. Kenk

Les sujets de discussions abordés à l'atelier de travail sont mentionnés dans le document de Fred Pollett reproduit dans le présent compte rendu. En voici un bref exposé:

- Rédaction d'un ouvrage de grande qualité consacré aux terres humides du Canada et destiné aux élèves des écoles secondaires et aux étudiants de première année.

- Préparation d'un symposium canadien sur les terres humides, qui se tiendrait au début des années 1980, possiblement à l'université du Manitoba.

- Préparation d'un système canadien de classification des terres humides, qui sera présenté au symposium national projeté.

- Etablissement d'un registre central des types de terres humides. Charles Tarnocai accepte d'approfondir cette idée et d'étudier la possibilité d'informatiser un tel registre.

- On a proposé et approuvé la tenue d'ateliers de travail annuels sur les terres humides.

- On a jugé utile de faire circuler un questionnaire en vue de connaître les personnes prêtes à contribuer aux activités du groupe de travail.

4. Atelier de travail sur l'organisation du CCCET

Participants: J. Thie - Président
J. Prokopchuk
A. Appleby
D. Bates
G. Marcotte
P. Duffy
M. Barnett
T. Friend
E. Macintosh
W. Eedy
P. Denison

Trois questions sont soulevées: l'ordre de priorité des futures activités du CCCET, l'avenir du groupe de travail Manipulation des données, le problème de la participation efficace de toutes les personnes intéressées aux activités du CCCET.

a) Ordre de priorité des futures activités:

Le groupe de travail juge qu'il convient en premier lieu d'organiser des cours d'une durée d'une à deux semaines, consacrés à l'utilisation des produits du CET. Ces cours devraient être offerts à l'échelon local ou régional.

Les autres objectifs les plus importants à atteindre sont la deuxième mise au point des lignes directrices du RET et la cartographie des régions écologiques du Canada. Les lignes directrices ne doivent pas être axées sur la taxonomie et, tout en adoptant une perspective nationale, elles doivent refléter les variations régionales. Non seulement la carte des régions écologiques est-elle considérée comme un instrument pédagogique important, mais elle offre aussi une perspective nationale sur les ressources du territoire. On estime qu'il vaut mieux suspendre la question d'un colloque national jusqu'à ce que la deuxième mise au point des lignes directrices et la carte des régions écologiques du Canada soit achevée. On considère plus urgent de créer des ateliers de travail sur la faune, d'étudier la façon de procéder aux relevés écologiques des terres et enfin de créer un atelier de travail sur la télédétection.

b) Devenir du groupe de travail sur la Manipulation des données:

On discute le problème du groupe de travail sur la Manipulation des données et on estime qu'il s'agit là d'un important secteur d'activité qui devrait être maintenu.

c) Réalisation d'une participation efficace:

La présente approche qui fait appel aux groupes de travail est considérée comme satisfaisante. On se dit également satisfait des bulletins, des compte rendus, des documents de travail et des colloques; il conviendrait toutefois d'accorder plus d'importance aux ateliers de travail locaux.

5. Atelier de travail sur les échanges d'information

Participants:

P. Glaude - Président	P. Rennick
K. Seel	W. Harris
P. Normandeau	N. van Waas
H. Luttmerding	D. Moon
A. Kerr	D. Cowell

Les membres de l'atelier de travail en arrivent à la conclusion que les échanges d'information technique et la communication avec le grand public et les divers organismes intéressés n'ont pas donné tous les résultats escomptés. Par ailleurs, la publication et la distribution des informations du CCCET ont été trop lentes et les principaux usagers doivent encore être identifiés.

L'atelier de travail produit la liste de recommandations (ci-dessous) sur les échanges d'information. Les membres conviennent qu'il n'est pas nécessaire de former un nouveau groupe de travail pour s'attaquer au problème, car les échanges d'information devraient normalement être l'affaire de tous les membres du Comité et un membre au moins devrait être désigné pour assurer le maintien d'un programme d'échange d'information efficace.

Recommandations:

- continuer à tenir des colloques, mais sur une base régionale, en encourageant la participation de toutes les personnes intéressées, que ce soit le public, l'industrie privée, les institutions ou les gouvernments, et en traitant des sujets intéressant toutes les régions;

- créer et publier un journal du CCCET qui traiterait des questions techniques et publierait des études, des analyses, des résumés, etc.;

- élaborer et publier une série numérotée de "rapports spéciaux";

- élaborer et promouvoir des cours sur le RET destinés aux institutions d'enseignement (écoles secondaires, universités, écoles supérieures de planification, etc.);

- dresser des bibliographies annotées pour les mettre à la disposition des écoles, des bibliothèques, du public, etc.;

- promouvoir l'application d'un système informatique relié au RET, en vue de démontrer la valeur et la maniabilité des données du RET;

- rédiger et distribuer une brochure d'information sur le CCCET destinée au grand public, mais en rapport avec des groupes, des projets et des problèmes précis, à l'aide d'exemples illustrés (causerie sur la forêt);

- parrainer une série de conférences publiques;

- se servir du système de télédistribution collective;

- faire appel aux organismes et aux établissements collectifs intéressés (par exemple, le Club Sierra, la Fédération des naturalistes de l'Ontario, etc.);

- encourager le personnel sur le terrain du RET à transmettre ses connaissances techniques d'un projet à l'usager;

- Le personnel du RET doit déterminer clairement l'objet, la valeur et les limites des données biophysiques présentées et doit en outre mettre en lumière la valeur et les limites d'application des cartes de base établies à partir de ces données;

- faire appel à l'expérience passée acquise par le CCCET, dans le but de démontrer aux usagers virtuels et au grand public en général l'évolution qu'a connue le RET. Proposer l'ITC comme exemple d'un système pratique;

- élaborer et promouvoir un véhicule qui permettra d'informer les gestionnaires des ressources, les spécialistes, les entrepreneurs, les hommes politiques et le public sur les modes d'application, la faisabilité, la méthodologie, les bénéfices et les coûts du RET et préparer des cahiers de documentation générale à l'intention de ces personnes;

- le CCCET doit donner la preuve aux gouvernements et au public de ses possibilités d'application, de sa valeur et de ses avantages pour le pays.

6. Ateliers de travail sur les lignes directrices relativement au RET

Participants:

Atelier A	Atelier B
P. Duffy - Président	D. Welch - Président
R. Lang	C. Tarnocai
D. Bates	A. Appleby
K. East	E. Macintosh
W. Eedy	P. Denison
P. Normandeau	M. Barnett
P. Rennick	N. Lopoukhine
H. Luttmerding	M. Walmsley
A. Kerr	G. Gagnon
P. Glaude	J. Prokopchuck
	G. Mills
	D. Moon
	A. Boydell

On demande à deux groupes de membres du Comité de discuter de la nécessité, la présentation et la production d'une deuxième mise au point des lignes directrices du RET. Les deux groupes aboutissent à des recommandations différentes sur cette question.

Le groupe A, présidé par Pat Duffy, juge nécessaire que les lignes directrices soient révisées immédiatement. En conclusion, le groupe considère que les lignes directrices devraient être suffisamment brèves pour pouvoir être utilisées facilement et que les sections spéciales (par exemple, les limites et les applications, l'intégration terre/eau, l'analyse des coûts et rendements, la classification de la végétation et les terres humides) soient réunies en volumes supplémentaires. Par ailleurs, les lignes directrices doivent se conformer aux recommandations particulières des groupes de travail du CCCET, elles doivent tenir compte des variations régionales dans leur approche et offrir une meilleure explication des principes du RET. Les nouvelles lignes directrices devraient être rédigées sur le modèle des lignes directrices de 1969, sous réserve des modifications justifiées par les récentes expériences du RET. On est d'avis que les concepts aussi bien que la terminologie du RET demandent à être éclaircis. Enfin, on accorde une importance de premier ordre à l'intégration des données.

La production de ces lignes directrices devrait exiger la participation de certains

du groupe initial chargé des lignes directrices, de la majorité des praticiens du RET, de représentants du gouvernement, de l'université et de l'industrie ainsi qu'un apport sur le plan théorique et dans le domaine du contrôle des coûts. En outre, comme les lignes directrices doivent être conçues en fonction de leur application, il est nécessaire que les usagers potentiels participent à leur élaboration. On estime que le projet devrait être financé par le gouvernement fédéral.

Pour sa part, le groupe B, présidé par David Welch, juge que des lignes directrices détaillées seraient peu susceptibles de rallier les esprits au départ et ne seraient pas acceptées par tout le monde. C'est ainsi que de nombreux projets continueraient à s'appuyer sur une approche et une méthodologie particulières. De même que dans l'autre groupe, les participants sont d'accord pour qu'il soit tenu compte de la variation régionale. On souligne également que les usagers ne comprennent souvent pas les données trop détaillées concernant un aspect du RET (par exemple le sol). C'est pourquoi les lignes directrices devraient être axées sur l'interprétation et la généralisation des données et conçues en fonction de l'usager. Les participants de l'atelier recommandent que les lignes directrices cessent d'être "des principes directeurs de la classification" pour devenir "des exemples de diverses approches", que l'accent soit porté sur les interprétations et les applications ainsi que sur l'explication détaillée de la méthodologie.

En ce qui concerne la présentation, le groupe propose les modalités suivantes:

1) un énoncé sur les concepts (se référer au groupe de travail Méthodologie/Philosophie)

2) un bref exposé des données demandées (par exemple pour la Commission d'examen des évaluations environnementales)

3) une référence aux systèmes de classification existants (par exemple le sol, le terrain)

4) des lignes directrices pour la classification des eaux, de la végétation, de la faune et des données socioéconomiques.

5) des exemples de projets en cours

6) des lignes directrices pour les interprétations et les applications.

Enfin, le groupe propose que l'établissement des lignes directrices soit confié au Secrétariat du CCCET et que la rédaction en soit confiée aux groupes de travail de cet organisme.

7. <u>Atelier de travail sur les régions écologiques</u>

Participants:

<u>S. Zoltai - Président</u>	B. Findlay
A. Boissonneau	G. Gagnon
E. Wiken	N. van Waas
K. Seel	G. Padbury
G. Wickware	E. Kenk
	F. Pollett

Les participants sont d'accord pour que la priorité soit donnée à l'établissement d'une carte des régions écologiques par le CCCET. La définition de la région écologique, sur laquelle les participants n'arrivent pas à se mettre d'accord, et l'échelle à adopter pour les cartes font l'objet d'une vive controverse. Il est recommandé que soit confiée au groupe de travail Méthodologie/Philosophie la tâche de définir la région écologique et le district écologique. On propose l'adoption d'une échelle de 1:1 000 000. La nature des renseignements que l'on désire communiquer à l'aide d'une telle carte est aussi vivement débattue et certains soutiennent que la carte doit être conçue pour répondre aux besoins de ses usagers et non pas le contraire.

Il est convenu que le CCCET est le seul organisme capable de produire une carte de ce genre et que l'on pourrait adopter une présentation comparable à celle des récentes études du Yukon et du Labrador mais en insistant davantage sur les relations entre les éléments écologiques. Enfin, on est d'avis qu'il est encore trop tôt pour essayer de prédire quel sera le coût d'un tel projet et que le CCCET devrait envisager la formation d'un groupe de travail sur les régions écologiques pour entreprendre cette tâche.

8. <u>Atelier de travail sur la végétation</u>

Participants:

<u>V. Gerardin - Président</u>
J. van Barneveld
S. Edlund
W. Harris
G. Marcotte
J. Levasseur
W. Bourgeois

Les membres de l'atelier de travail sur la végétation discutent de la possibilité d'établir une base commune pour l'analyse

de la végétation dans tout le Canada. Ils ont des doutes sur la valeur de cette idée en raison du caractère varié de la végétation canadienne et ils soulignent le caractère nettement particulier des problèmes. Certains membres ne voient pas présentement la nécessité de former un groupe de travail sur la végétation à l'intérieur du CCCET.

9. Atelier de travail sur la planification écologique de l'utilisation des terres

Participants:

K. East - Président	D. Luff
A. Boydell	J. Crosby-Diewold
R. Lang	E. Wiken
P. Rennick	S. Rowe
P. Glaude	H. Slavinski
A. Friend	A. Appleby
D. Cowell	F. Pollett

Le groupe estime nécessaire de concevoir la planification en fonction des besoins humains en tenant compte le plus possible de l'environnement. Au demeurant, la planification de l'utilisation des terres sera, dans un avenir prochain, une activité à prédominance socioéconomique et les objectifs de la planification détermineront dans quelle mesure l'environnement influera sur les prises de décisions. On propose une série de recommandations en vue d'en arriver à une planification acceptable du point écologique ou environnemental.

- Poursuite des programmes de relevés régionaux en vue d'établir une base de données élargie pour une planification régionale judicieuse ouvrant la voie à la planification zonale, dont les effets accumulés pourraient s'avérer défavorables.

- Examen de la question des "systèmes de valeur" dans le processus de prise de décisions afin de s'assurer que ce dernier fera place à une conscience plus aiguë des problèmes écologiques.

- l'élaboration d'une série d'indicateurs environnementaux qui joueront peut-être un rôle plus important dans l'élaboration des politiques tant nationale que provinciale.

- Etablissement d'un conseil environnemental ou écologique indépendant d'envergure nationale ou provinciale, qui serait chargé de contrôler l'état de l'environnement et de produire des rapports annuels sur la situation.

10. Atelier de travail sur la présentation et la communication de l'information

Participants:

M. Barnett - Président	D. Bates
N. van Waas	J. van Barneveld
G. Padbury	V. Gerardin
S. Nikleva	E. Macintosh
G. McCullough	H. Luttmerding
W. Harris	R. Fulton
W. Bourgeois	G. Gagnon
S. Lamont	

Les membres de l'atelier en arrivent à la conclusion qu'il existe un défaut de communication entre la base de données du RET et ses usagers. Cette situation serait en partie attribuable au retard dans la livraison des données à l'usager ainsi qu'à la quantité et à la complexité des données qui lui sont présentées. La résolution de ces problèmes pose certaines difficultés et, parmi les solutions proposées pour accroître la compréhension mutuelle, il faut éviter le recours au jargon et de simplifier la présentation des données (par exemple, la cartographie alphanumérique). Il convient de souligner aux usagers les limites inhérentes aux échelles des cartes, c'est à dire de les tenir au courant des variations d'exactitude à différentes échelles. Le groupe pense que le CCCET devrait organiser des ateliers de travail pour les usagers afin d'en arriver à une meilleure compréhension entre les responsables de la production et les usagers des données du RET.

11. Atelier de travail sur les coûts et rendements

Participants:

W. Eedy - Président	J. Levasseur
P. Duffy	G. Wickware
J. Ducruc	H. Rostad
S. Zoltai	D. Welch
P. Normandeau	L. van Vliet
A. Kerr	G. Mills
J. Prokopchuck	N. Lopoukhine

L'atelier de travail sur les coûts et rendements a pour objectif d'examiner la base de données du RET, ainsi que les avantages et les inconvénients de l'approche du RET par opposition aux relevés classiques, du point de vue des coûts et rendements. Les membres dressent la liste suivante des avantages et des inconvénients de l'approche.

a) Avantage - Les données intégrées sont maniables et offrent un cadre général.

Inconvénient - La base de données est trop souple, d'où vient que les disciplines isolées risquent d'être dans la masse.

b) Avantage - L'adoption d'échelles et de frontières communes pour les cartes rend le stockage des données plus facile et moins onéreux.

Inconvénient - L'usager doit être formé à la manipulation de ces données.

c) Avantage - L'approche permet une utilisation économique des ressouces sur le terrain, qui permet à son tour une stratification des échantillonnages.

Inconvénient - L'exercise des relevés sur le terrain risque de poser des problèmes, car certaines disciplines exigent des rythmes de travail différents et la collecte des données varie en fonction de facteurs saisonniers.

d) Avantage - Il est plus économique de produire une base cartographique pour la présentation intégrée des données.

Inconvénient - Une base cartographique peut donner lieu à des présentations de données hautement complexes.

e) Avantage - Cette base est durable, puisque les éléments écologiques représentés ne changent pas, excepté ...

Inconvénient - Sur les cartes à grande échelle où les frontières et les éléments cartographiques peuvent changer au fil des ans.

f) Avantage - Il sera facile de convaincre les administrateurs de l'intérêt de la formule du RET.

Inconvénient - Il y a danger qu'un trop grand nombre de données soit produit, alors que les dépenses et l'allocation des ressources aux participants doivent être contrôlées.

g) D'une façon générale, le RET permet de planifier dans un cadre globaliste de l'environnement et autorise une approche dynamique des facteurs écologiques.

Les membres de l'atelier sont d'avis que le rapport coût-rendement des projets du RET pourrait être amélioré si l'on confiait la responsabilité de l'équipe du RET et de l'allocation des ressources à une seule personne, si l'on évaluait exactement les besoins des usagers pour ce qui touche les échelles et les données et si l'on se servait des données existantes, afin d'éviter le gaspillage d'efforts.

Pour démontrer les aspects coût-rendement des projets actuels du RET, le CCCET doit chercher à convaincre le public des avantages écologiques du RET, faire comprendre en termes simples l'approche employée pour le RET et distribuer aux responsables de projets des questionnaires détaillés concernant les coûts et l'estimation des coûts qu'entraînerait la réalisation d'une même étude par une approche unidisciplinaire.

En ce qui touche la répartition des coûts, les membres de l'atelier estiment que la plus grande partie de l'argent et du temps dont on dispose devrait être consacrée à la préparation, à la collecte et à l'analyse des données et qu'une proportion de 20 a 25 % du budget devrait être consacrée à la présentation des données. Il serait bon de tenir compte du temps ainsi que des coûts réels dans la planification du RET et dans l'établissement des coûts estimatifs.

Enfin, dans la poursuite de l'analyse des coûts et rendements, il serait bon d'évaluer la valeur prévisionnelle du RET et de contrôler la satisfaction de l'usager ainsi que son avis sur les possibilités d'application des données.

12. Atelier de travail sur les lignes directrices d'interprétation

Participants:

W. Holland - Président	R. Hart
S. Edlund	J. Thie
P. Duffy	R. Travers
C. Tarnocai	G. Mills
K. Seel	D. Moon
J. Prokopchuck	E. Kenk
B. Findlay	T. Chamberlin
J. Crosby-Diewold	

Le groupe discute de la nécessité de lignes directrices d'interprétation en vue de mettre les autres organismes et le public au courant

des activités relatives au RET. Le groupe recommande la mise sur pied d'un comité officiel du CCCET qui se pencherait sur le problème et tenterait de lancer un projet pilote en se servant des données d'un relevé écologique donné.

SESSION D'AFFAIRES DÉFINITIVE

La présidence du CCCET

Au début de la session, Bob Fulton rapporte les conclusions du comité spécial mis sur pied par Jean Thie pour élaborer des recommandations applicables à la présidence du CCCET. Voici la liste de ces recommandations:

a) que soit maintenu le principe de rotation du poste de président parmi les représentants des organismes gouvernementaux et non-gouvernementaux ainsi que des régions,

b) que la Direction générale des terres soit invitée à fournir un directeur exécutif au CCCET. Le Directeur exécutif devrait être investi d'attributions qui lui permettent de jouer un rôle de premier plan dans la direction du CCCET. Le rôle du président devrait être axé davantage sur la direction de la politique générale (les fonctions du directeur exécutif seront comparables à celles d'un sous-ministre et les fonctions du président à celles d'un ministre),

c) que J. Thie soit invité à occuper le poste de président pour une autre année pendant qu'on s'occupe à organiser et à combler le poste de directeur exécutif,

d) que soit formé un comité composé du directeur exécutif, du président actuel et du président du groupe de travail, dans le but de rechercher un nouveau président. Les candidatures doivent être soumises à ce comité pour être examinées.

Sommaire et discussion des ateliers de travail

Au nom du Secrétariat du CCCET, David Welch et Ed Wiken ont analysé les rapports produits par l'ensemble des ateliers de travail et ont préparé pour la session finale sur les activités un sommaire qui sera examiné en comité plénier.

Un bon nombre des recommandations des ateliers de travail ont pris la forme de propositions adressées aux groupes de travail, au Secrétariat, aux responsables des projets et à des personnes en particulier, sur la façon de normaliser leurs méthodes et de mettre au point une application plus vaste du relevé écologique des terres. Toutefois, pour cette session finale, seules les recommandations touchant aux activités du CCCET ont été formulées. Cela s'explique du fait que les nombreux commentaires, propositions et discussions qu'ont fait naître les réunions de portée générale étaient révolus et qu'ils s'agirait à l'avenir, pour le CCCET, de se consacrer davantage aux tâches spéciales, notamment aux diverses publications et aux réunions de caractère technique. Cette perspective a débouché sur la liste de recommandations ci-après.

Recommandations touchant les groupes de travail

a) Méthodologie/Philosophie:

- le groupe de travail Méthodologie/Philosophie devrait s'appliquer à définir les termes, en particulier les notions de région écologique et de district écologique.

b) Intégration terre/eau:

- la création d'un atelier de travail national ne s'impose pas dans l'immédiat

- le groupe de travail terre/eau devrait être orienté vers la formation de petits groupes d'activité de niveau technique (séances avec photographies aériennes, par exemple)

- le groupe devrait commencer l'élaboration des lignes directrices

- il est nécessaire d'accroître le degré de concertation entre les groupes de travail

- Jean-Pierre Ducruc sera le nouveau président du groupe de travail

c) Terres humides:

- un des principaux projets consiste en un manuel des terres humides du pays qui sera préparé avec l'aide des régions et sous la direction de Fred Pollett et qui paraîtra d'ici 1981

- un registre des terres humides sera établi sous la direction de Charles Tarnocai

- les ateliers de travail annuels et les voyages d'études se poursuivront

- un questionnaire sera mis au point à l'intention des personnes figurant sur la

liste de distribution.

d) Manipulation des données:

- ce groupe n'a formulé aucune recommandation mais les participants à l'atelier de travail sur l'organisation du CCCET ont souligné son importance et ont recommandé que des activités soient confiées à ce groupe de travail

e) Groupes de travail proposés:

- comme on n'a pu se mettre d'accord sur la possibilité d'établir un groupe de travail sur la végétation, on a recommandé d'abandonner temporairement le projet.

f) Interprétation:

- on a jugé qu'il serait nécessaire de former un tel groupe en vue d'élaborer des lignes directrices pour l'interprétation des données du RET. La présentation de ces lignes directrices pourrait se faire par la publication de chaque demande de projet ou par leur inclusion dans les lignes directrices du RET.

g) Régions écologiques:

- les participants ont convenu de la nécessité de lancer un projet national de cartographie des régions écologiques. Ce projet pourrait être dirigé par un nouveau groupe de travail qui travaillerait de concert avec les autres groupes pour ce qui touche les définitions. Il resterait encore à obtenir des fonds pour financer le projet.

Nombre de recommandations sommaires ci-dessus ont été adoptées d'emblée. En revanche, un certain nombre de points ont dû être longuement débattus avant de faire l'objet d'un accord.

Organisation du CCCET

- Il est nécessaire d'en arriver à une plus grande interrelation entre les groupes de travail. Dans certains cas, la participation simultanée à plusieurs groupes pourrait permettre d'atteindre ce résultat, mais le plus souvent, il s'agirait d'augmenter les échanges de correspondance et de rapports.

- Le groupe de travail sur les applications decrait être chargé d'ébaborer les lignes directrices en matière d'interprétation des données écologiques des terres. Dans ce contexte, l'applictation désigne une utilisation, l'interprétation ou l'évaluation des données et non pas l'application des méthodes de classification écologique du territoire au relevé des terres.

Lignes directrices

- On a généralement convenu de la nécessité de mettre à jour les lignes directrices existantes, de reconnaître la diversité qui caractérise la classification écologique du territoire dans l'ensemble du pays, et de mettre particulièrement l'accent sur la justification (ou les avantages) des relevés écologiques des terres.

- Les lignes directrices devraient comporter des termes courants, des sections sur le contenu des relevés, des échelles de carte, des méthodes d'interprétation, etc. ainsi qu'une série de projets types soigneusement sélectionnés, qui refléteraient des différences d'environnement, de spécialisation et d'objet du relevé choisi comme exemple.

- C'est avant tout au secrétariat du CCCET que devrait revenir la responsabilité de produire les lignes directrices mais il conviendrait également d'acceuillir toutes les contributions spontanées. Il conviendrait de connaître la réaction des groupes de travail et de leur président aux lignes directrices, et ces dernières devraient recevoir l'approbation du CCCET.

* * * * *

À la suite de cette discussion, Jean Thie remercie Tony Boydell et Clay Rubec d'avoir organisé la conférence et d'en avoir assuré le succès. Il remercie tout spécialement CLay Rubec qui a non seulement contribué à l'organisation de la conférence, mais a aussi réuni et préparé, pour les distribuer à la réunion, les nombreux documents de base rédigés par les participants.

Sur ces remarques, Jean Thie annonce la fin de la réunion.

REPORTS OF CHAIRMEN AND WORKSHOPS

RAPPORTS DES PRÉSIDENTS ET DES ATELIERS

CCELC CHAIRMAN'S REPORT

J. Thie
Lands Directorate
Environment Canada
Ottawa, Ontario

It is almost two years since the Canada Committee on Ecological (Biophysical) Land Classification was established. The first meeting of this national committee, held in May 1976 in Petawawa, Ontario, reported on the present status of ecological (biophysical) land classification (ELC) in Canada, and defined the objectives and modes of operation of the Committee. This second meeting is dedicated to discussing the present status of use of ELC data in resource planning and management. The third meeting of the CCELC hopefully will be directed to the approval of a new, more comprehensive set of guidelines for ELC.

As I would like to report on the activities of the Committee as a whole, I would like to repeat here the objective of the CCELC which guided our efforts and by which we should measure our achievements:
To encourage the continued development and to promote the application of a uniform ecological (biophysical) approach to land classification for resource planning, management and environmental impact assessment purposes.

This objective is to be achieved through:

(i) technical information exchange and organization of problem-oriented working groups and workshops;
(ii) encouragement and wide distribution of information on methodology and applications of ecological (biophysical) surveys;
(iii) the initiation of dialogue with the general public and users on the presentation and application of ecological information; and
(iv) recommendations and advice to governmental and private agencies on the application, feasibility, methodology, benefits and costs of ecological (biophysical) type surveys.

In addition, the Petawawa meeting generated a set of recommendations. These were translated, at least partially, into our program.

CCELC accomplishments to-date have included the following:

- A permanent secretariat was set up in the Ecological Land Classification and Evaluation Division of the Lands Directorate. It is supported by staff of that Division — Ed Wiken, David Welch, Clay Rubec, Gary Ironside, Tom Pierce and Marg Poulin.

- A CCELC mailing list was compiled with about 1,300 names, and Newsletters, edited by Ed Wiken, are mailed out periodically.

- An index of ELC land surveys in Canada will be updated annually by David Welch.

- As recommended at Petawawa, we organized a successful workshop on *Ecological Land Classification in Urban Areas*. The credit for this work should go to Ed Wiken.

- Proceedings of the Petawawa and Toronto meetings were published in the Ecological Land Classification Series of the Lands Directorate.

- Working groups of the CCELC, dealing with Wetland Classification, Methodology/Philosophy, Land/Water Integration, Data Systems, and Applications, were chaired respectively by Fred Pollett, Stan Rowe, Nick Lopoukhine, Dick Marshall and myself. Unfortunately, Dick Marshall, due to increased responsibilities with the provincial government in B.C., was unable to devote sufficient time to his working group.

- The chairmen of the working groups met with Tony Boydell in September 1976, in Winnipeg, to discuss CCELC programs and priorities for a three-year period. The working group activities resulting from this meeting will be reported separately by the chairmen. Highlights include: the excellent discussion paper on the philosophy and methodology of ELC by the Methodology/Philosophy Working Group; the proceedings of the Land/Water workshop in Winnipeg, compiled by David Welch; and the Wetlands Workshop in Newfoundland.

The interest in the activities of CCELC and its working groups has been greater than expected.

The various working groups take different approaches to involving those across Canada who want to participate. I am not certain what the best method is, if there is a best method, to involve effectively everyone interested; it is very important that this meeting provide the working group chairmen some direction. Another important business aspect of the meeting is to decide what our activities should be for the next 2-3 years, and on a long term basis. Attention should particularly be given to assigning priorities. As our committee basically operates on goodwill and voluntary contributions, we cannot take on too much at any one time. We have to phase out projects. From my viewpoint, the CCELC should take some new initiatives in the next few years, and revive a few as well. Your discussions, recommendations and assignment of priorities should include the following topics:

- <u>second approximation of guidelines for ELC</u>: outline, format, organization; who should do what?

- <u>an ecoregion and ecodistrict mapping of Canada</u>: should this be a CCELC project, and how can it be done?

- <u>National Symposium on ELC planning and Management</u>: would it be useful at this time to organize a major symposium?

- <u>Urban Working Group in the CCELC</u>: the Toronto Workshop made recommendations to that extent.

- <u>Workshop on Vegetation</u>: ad hoc working group? The time appears right to take some initiatives in this area.

- <u>Workshop on the Use of Remote Sensing Sensing for Ecological Land Classification</u>.

The above topics are the major ones that come to my mind. I am sure that the working group chairmen and the workshops will raise other activities that have to be considered.

The theme of this meeting is the use of ELC information in the planning and management process. Many of the participants today have obliged to write a background paper for discussion. To allow for extensive workshop sessions, only a few of those are being presented on the second day. I hope that the papers and the workshop sessions will give us a clear picture of the present status of the use of ELC. I trust that we can launch a successful applications program and make our actions with users more effective.

Jean Thie

RAPPORT DU PRÉSIDENT DU CCCET

J. Thie
Direction générale des terres
Environnement Canada
Ottawa, Ontario

Le Comité canadien de la classification écologique (biophysique) des terres existe depuis presque deux ans. Aujourd'hui a lieu la deuxième réunion nationale de ce comité. Lors de la première réunion tenue à Petawawa, on a traité de l'état de la classification écologique (biophysique) des terres (CET) au Canada et défini les objectifs et modes d'opération du comité. Au cours de la réunion d'aujourd'hui, tenue à Victoria, on s'entretiendra sur l'état actuel de l'utilisation des données de la CET dans la planification et la gestion des ressources. Nous espérons que la troisième réunion du comité sera orientée vers l'approbation d'une série de lignes directrices nouvelles et plus détaillées pour la CET.

Avant de vous faire rapport sur les activités du comité, je désirerais rappeler les objectifs qui ont guidé nos efforts et en fonction desquels nous pouvons mesurer nos réalisations:

Favoriser le développement et l'application d'une approche écologique (biophysique) uniforme à la classification des terres pour des fins de planification des ressources, de gestion et d'évaluation des répercussions sur l'environnement.

Ce but doit être atteint par:

(i) l'échange de renseignements techniques et l'organisation de groupes de travail et d'ateliers chargés de cerner les problèmes;

(ii) la distribution à grande échelle des renseignements relatifs à la méthodologie et aux applications des études écologiques (biophysiques);

(iii) la pratique du dialogue avec le grand public et les utilisateurs sur la présentation et l'application des renseignements d'ordre écologique;

(iv) la formulation de recommandations et la prestation de conseils aux organismes gouvernementaux et privés, relativement à l'application, la méthodologie, les avantages et les coûts des études écologiques (biophysiques).

En outre, une série de recommandations est ressortie de la réunion de Petawawa. Ces dernières ont été intégrées, du moins en partie à notre programme.

- Les présidents des 5 groupes de travail étaient censés approcher des personnes de calibre telles que Stan Rowe, Fred Pollett, Nick Lopoukhine et Dick Marshall. Malheureusement, Dick Marshall n'a pu consacrer suffisamment de temps aux groupes de travail en raison de ses responsabilités croissantes au gouvernement provincial de la Colombie-Britannique.

- On a créé un secrétariat permanent à la Division de l'évaluation et de la classification écologique des terres de la Direction générale des terres. Des employés de la Division, en particulier Ed Wiken, David Welch, Clay Rubec, Gary Ironside, Tom Pierce et Marg Poulin s'occupent de ce secrétariat.

- On a rédigé une liste de 2 000 noms de personnes qui reçoivent les bulletins trimestriels publiés par Ed Wiken.

- On a commencé à rédiger un index des études sur les terres du CET au Canada. Ce dernier sera mis à jour chaque année par David Welch.

- Comme il avait été proposé à Petawawa, nous avons organisé un atelier sur la classification écologique des terres dans les centres urbains. Nous devons la réussite de ce travail à Ed Wiken.

- Les procès-verbaux des réunions de Petawawa et Toronto ont été publiés dans la série de documents relatifs à la classi-

fication écologique des terres de la Direction générale des terres.

- En septembre 1976, Tony Boydell et moi-même, nous sommes réunis avec les présidents des groupes de travail à Winnipeg afin de nous entretenir sur les programmes et priorités du CCCET pour une période de trois ans. Chaque groupe de travail rendra compte de ses activités résultant de cette réunion. En voici les points saillants: l'excellente analyse rédigée par le groupe de travail de Stan Rowe sur les principes et la méthodologie du CET; les procès-verbaux de l'atelier sur les terres et l'eau tenu à Winnipeg, rédigés par David Welch; et les résultats de l'atelier sur les terres mouillées tenu à Terre-Neuve.

On a été agréablement surpris de voir que l'intérêt porté aux activités du CCCET et de ses groupes de travail a été plus grand que prévu.

Les divers groupes de travail s'y prennent différemment pour faire participer les intéressés dans tout le Canada. Cependant, je ne peux pas affirmer quelle méthode est la meilleure, s'il en est, pour faire participer de façon efficace tous les intéressés. Cette réunion doit absolument nous fournir, aux présidents des groupes de travail et à moi-même, certaines indications en ce sens. Il faut aussi décider au cours de cette réunion quelles seront nos activités au cours des deux, trois prochaines années et à long terme. On doit accorder une attention particulière à l'ordre des priorités. Etant donné que notre comité fonctionne fondamentalement en vertu de la bonne volonté de chacun, il ne faut pas abuser. Nous devons échelonner nos projets. A mon avis, le CCCET devrait prendre quelques nouvelles initiatives au cours des prochaines années et reprendre certaines activités. Vos entretiens, recommandations et priorités devraient comprendre les sujets suivants:

- <u>une deuxième ébauche de lignes directrices</u> pour la CET; aperçu, présentation, répartition des tâches;

- <u>une mise en carte des écorégions du Canada</u>; cela devrait-il être un projet du CCCET, et comment peut-il être exécuté?

- <u>la tenue d'un symposium national</u> sur la planification et la gestion de la CET; en ce moment, serait-il utile d'organiser un symposium important?

- <u>la création d'un groupe de travail sur les centres urbains</u> à l'intérieur du CCCET; lors de l'atelier tenu à Toronto, on a fait des recommandations à ce sujet;

- <u>la tenue d'un atelier sur la végétation</u>: un groupe de travail spécial? il semble opportun de prendre certaines initiatives dans ce domaine;

- <u>l'organisation d'un atelier sur l'utilisation de la télédétection</u> pour la classification écologique des terres.

Voilà donc les principaux sujets qui me viennent à l'esprit. Je suis certain que les présidents des groupes de travail soulèveront d'autres activités dont on doit tenir compte et que les ateliers en feront ressortir aussi.

La réunion d'aujourd'hui a pour thème l'utilisation des informations de la CET dans le processus de planification et de gestion, et nombre de participants ont eu la gentillesse de rédiger des communications. Afin de permettre la tenue d'ateliers vraiment valables, seulement quelques-uns sont prévus pour la deuxième journée. J'espère que les exposés et les ateliers nous donneront une idée précise de l'état actuel de l'utilisation de la CET. D'après ces résultats, j'espère que nous pourrons lancer un programme d'applications réussi et rendre nos rapports plus efficaces avec les utilisateurs.

Jean Thie

REPORT OF THE LAND/WATER INTEGRATION WORKING GROUP

N. Lopoukhine
Lands Directorate
Environment Canada
Halifax, N.S.

HISTORICAL PERSPECTIVE

Aquatic resource data have systematically been left out of integrated ecological land inventories. Water data were and are often presented as supplementary information and not integrated with the land component. Therefore, it wasn't surprising that in the discussion paper prepared in November 1975 by the Ad Hoc Committee on Biophysical Classification, the integration of land and water was targeted as a possible working group activity. As a consequence, at the first meeting of the CCELC in May 1976 at Petawawa, Ontario, one of the working groups organized was assigned the following terms of reference:

...to advise on the feasibility and necessity of a biophysical classification scheme, that will compatibly incorporate water with the surrounding terrain, this working group should focus upon the needs for inland and coastal land/water classification, and then upon the compatibility with existing ecological classification.

The following September, Working Group chairmen met in Winnipeg to discuss and set goals for each group for a three-year period. The goals identified for the Land/Water Integration Working Group follow.

1. Establishment of three sub-groups on the basis of region and focus:
   (a) sub-group Pacific - concentration on coastal and cordillera land/water classification
   (b) sub-group Central - concentration on inland areas of land/water classification
   (c) sub-group Atlantic - concentration on coastal classification.

2. Organization of a workshop as a means of discussing and resolving some fundamental questions related to the integration of land and water:
   (a) Is integration of land and water viable?
   (b) What is the current state of the art?
   (c) Who are or will be the users and what are their needs?

3. The workshop proceedings were to be published and widely circulated.

ACTIVITIES

Given the above terms of reference and identified goals, a first meeting of the Working Group was organized. The persons recruited to attend the first meeting represented a variety of interests. Generally, a multidisciplinary atmosphere was intended by inviting "users", "scientific sources", and "classifiers". In addition to these categories, the participants were separable on the basis of coastal and inland interest and to some extent on a Regional basis. Thirteen of the fifteen invited people met in Winnipeg in February 1977 for the Working Group's first meeting.

The structure of the meeting was along the lines of a workshop. The state of the art of land/water classification in B.C., Manitoba and Quebec were presented first. This was followed by a formal presentation by each participant on his interest and activity in land/water integration. Discussions on a wide ranging number of topics followed. Near the end of the 1.5 day meeting, the group split into two for discussions of a number of selected topics. This session led to a list of recommendations which were submitted to the Working Group for adoption.

The following recommendations were adopted:

1. The integration of land and water is, in principle, a viable proposal.

2. Coastal and inland waters would be treated by one group although a future

splitting up of the working group would be inevitable. (The establishment of sub-groups has been postponed).

3. A workshop on land/water integration is to be held in the future.

4. A canvassing of the persons on the mailing list should be carried out to determine the areas of interest and needs in land/water classification. Interest in a workshop should also be determined by a questionnaire.

5. A bibliography of examples of land/water integration was to be prepared in advance of a workshop.

6. The exchange of information on land/water integration was to be promoted.

Since the initial meeting the following actions have been taken on the recommendations:

1. A questionnaire has been prepared and has been sent out to the people on the mailing list. Currently the list consists of 600 names.

2. A bibliography was in preparation by D. Welch of Lands Directorate, Ottawa, at the time of the February meeting and is now near the publishing stage. This publication is more than an annotated bibliography of attempts at the integration of land and water. It also includes a section on the ecological significance of aquatic features as a basis for management and planning. Specific parameters and their ease and feasibility of collection are also discussed. Based on the above, the aquatic unit is defined for mapping purposes. Not only does this report bring under one cover a review of the state of the art, but it also suggests approaches to the integration of land and water. In that sense it will prove to be valuable to the working group and as a basis of a workshop.

3. The exchange of information has been initiated by circulating the proceedings of the Working Group's first meeting. The proceedings were compiled and edited by D. Welch.

4. A decision on holding the workshop is pending upon the interest shown via the responses to the questionnaire.

REFLECTIONS

The land/water integration Working Group, like other Working Groups, has been in existance for approximately two years. In that time, given the lack of a formal budget and the general prevailing climate of fiscal constraint, the achievements have been limited to the laying of the groundwork for ecological land/water classification. The slow nature of the committee process has led to criticism of the Working Group for not proceeding with actual classification work.

The impatience expressed in this criticism is shared by all those involved in the Working Group. In general, it is frustrating, and to some extent discouraging, to see so little progress. Yet the bottom line is that progress has been made as the following attest.

1. The viability of land/water integration has been agreed upon by a group of classifiers and non-classifiers attending the initial meeting of this Working Group.

2. Dave Welch is near publishing a document on the state of the art. This document will be of particular help in developing guidelines of land/water integration for ecological land classification.

3. Questionnaire responses already received are indicating the needs and interests necessary for classification development.

4. The principles and philosophy behind the integration of land and water as discussed at the first meeting of the Working Group were documented in the proceedings and given a wide circulation.

ASPIRATIONS

Entering the third year of its existance, the Land/Water Working Group faces a number of points which will require resolution and action in the immediate future. The agenda of the second national meeting of the CCELC includes a series of Working Group workshops, these will be excellent forums for a discussion of the points and questions which follow.

1. The workshop goal has not been achieved. In fact, some reservations have been raised on the utility of convening a workshop. Given the initial meeting, D. Welch's impending publication and other information exchanges, what else may be achieved through a workshop at this time?

2. Workshops generate interest and, specifically, related activity. Without a workshop to generate the above, what other avenues exist in order to propagate research on the question of how and what?

3. One suggestion is to produce a technical document, a sort of first approximation of land/water integration. This would be carried out by a core group and distributed for criticism.

4. The development of guidelines or any other technical document must be tied in with the other Working Groups. In particular the Wetlands and Methodology/Philosophy Working Groups should be held in close contact. How is this best achieved.

RAPPORT DU GROUPE DE TRAVAIL INTÉGRATION TERRES/EAU

N. Lopoukhine
Direction régionale des terres
Environnement Canada
Halifax, N.É.

PERSPECTIVE HISTORIQUE

Les données sur les ressources aquatiques ont été systématiquement négligées dans les inventaires écologiques intégrés des terres. Les données relatives à l'eau ont été et sont encore souvent fournies à titre de renseignements supplémentaires au lieu d'être intégrées aux données concernant les terres. Rien d'étonnant dans ces conditions que le document de travail rédigé en novembre 1975 par le Comité de la classification biophysique ait identifié l'intégration terre/eau comme domaine éventuel d'un groupe de travail. C'est ainsi que lors de la première réunion du Comité canadien de classification écologique du territoire, tenue en mai 1976 à Petawawa (Ontario), un des groupes de travail mis sur pied a reçu le mandat suivant:

"fournir des conseils quant à la faisabilité et à la nécessité d'un plan de classification biophysique, intégrant les données relatives à l'eau et au sol environnant, plus spécialement sur les besoins en matière de classification terre/eau pour les régions intérieures et côtières, puis sur l'harmonisation de cette classification avec la classification écologique existante".

Au mois de septembre suivant, les présidents des divers groupes de travail se sont réunis à Winnipeg pour débattre et déterminer l'objectif à attribuer à chaque groupe pour les trois années suivantes. Les objectifs assignés au Groupe de travail sur l'intégration terre/eau sont les suivants.

1. créer trois sous-groupes régionaux et leur confier les tâches prioritaires suivantes:
   (a) sous-groupe du Pacifique: classification terre/eau en régions côtières et en montagne
   (b) sous-groupe central: classification terre/eau des régions intérieures et
   (c) sous-groupe de l'Atlantique: classification des régions côtières.
2. mettre sur pied un atelier pour débattre et résoudre un certain nombre de questions fondamentales reliées à l'intégration terre/eau, en particulier celles-ci:
   (a) une intégration terre/eau est-elle viable?
   (b) où en est cette question?
   (c) quels sont les utilisateurs actuels et futurs de telles données et quels sont leurs besoins?

ACTIVITÉS

Après s'être vu confier ce mandat et ces objectifs, le groupe de travail a tenu une première réunion. Les personnes invitées avaient des intérêts divergents. Dans l'ensemble, on a tenté de créer une atmosphère multidisciplinaire en faisant appel à des utilisateurs, à des scientifiques et à des classificateurs. Outre ces catégories, les participants pouvaient être répartis selon leur intérêt pour les régions côtières ou intérieures et, dans une certaine mesure, sur une base régionale. Treize des quinze personnes invitées se sont donc réunies à Winnipeg, à cette occasion, en février 1977.

Cette réunion s'est déroulée comme un atelier. On a d'abord fait l'état de la question de la classification terre/eau en Colombie-Britannique, au Manitoba et au Québec. Ensuite, chaque participant a décrit en détail l'intérêt qu'il porte à l'intégration terre/eau et ses activités dans ce domaine. On a ensuite discuté d'un grand nombre de questions. Vers la fin de la réunion, qui a duré une journée et demie, le groupe s'est réparti en deux sous-groupes afin de discuter d'un certain nombre de sujets choisis. Cette réunion a donné lieu à la rédaction d'une liste de recommandations qui a été soumise pour adoption au groupe de travail.

Les recommandations suivantes ont été adoptées:

1. l'intégration terre/eau est en principe viable.

2. les eaux côtières et intérieures pourraient être confiées à un même groupe, bien qu'il soit inévitable, à l'avenir, de scinder le groupe de travail. (En d'autres termes, la création de sous-groupes a été reportée à plus tard).

3. un atelier sur l'intégration terre/eau doit être tenu plus tard.

4. on devrait passer en revue les personnes figurant sur la liste de distribution, afin de déterminer leurs centres d'intérêt et leurs besoins en matière de classification terre/eau. Il faudrait également determiner au moyen d'un questionnaire l'intérêt que chacun porterait à un atelier.

5. en prévision d'un atelier, il convient de dresser une bibliographie contenant des exemples d'intégration terre/eau et

6. il faut encourager l'échange de données relativement à l'intégration terre/eau.

Depuis la première réunion, les mesures suivantes ont été adoptées en fonction des recommandations:

1. un questionnaire a été dressé et envoyé aux personnes figurant sur la liste de distribution, qui compte actuellement 600 noms.

2. lors de la réunion de février, D. Welch, de la Direction générale des terres, à Ottawa, avait entrepris l'élaboration d'une bibliographie, qui est maintenant sur le point d'être publiée. Il s'agit là de bien plus qu'une bibliographie annotée relatant des tentatives d'intégration terre/eau. Elle comporte en outre une partie exposant l'importance écologique des données aquatiques comme base de gestion et de planification. On a examiné certains paramètres ainsi que la possibilité et la facilité d'en faire le relevé. A partir de ces renseignements, l'unité "eau" est déterminée en vue des relevés topographiques. Ce rapport, non seulement résume en un seul ouvrage l'état de la question, mais fait également des suggestions quant à une intégration terre/eau. C'est la raison pour laquelle il sera certainement apprécié par le groupe de travail et servira de base à l'atelier.

3. l'échange d'information a été lancé par la diffusion du procès-verbal de la première réunion du groupe de travail, qui a été dressé par D. Welch et

4. la tenue éventuelle d'un atelier est une question toujours pendante et qui sera fonction des réponses fournies au questionnaire.

RÉTROSPECTIVES

Comme d'autres groupes, le Groupe de travail sur l'intégration terre/eau existe depuis environ deux ans. Etant donné l'absence d'un budget officiel et le climat général de contraintes financières, it n'a pu au cours de cette période qu'effectuer le travail de base en vue d'une classification écologique terre/eau. On a reproché au groupe de travail d'avoir procédé avec lenteur et, en particulier, de n'avoir pas effectué le travail même de classification.

L'impatience dont témoigne ces critiques est partagée par tous les membres du groupe. Dans l'ensemble, en effet, il est frustrant et, dans une certaine mesure, décourageant, de voir qu'aussi peu de progrès ont été accomplis. Néanmoins, il y a eu progrès, en particulier sur les points suivants:

1. la viabilité d'une intégration terre/eau reconnue par les classificateurs et les non-classificateurs participant à la première réunion du groupe de travail.

2. Dave Welch va publier incessamment un document faisant le point de la question. Ce document sera d'une importance particulière lorsqu'il s'agira de définir les lignes directrices d'une intégration terre/eau dans le cas d'une classification écologique des terres.

3. les réponses déjà reçues au questionnaire témoignent de l'intérêt et de la nécessité d'élaborer une telle classification et

4. les principes et la philosophie qui sous-tendent une intégration terre/eau, dont il a été question lors de la première réunion du groupe de travail, ont été commentés au procès-verbal et largement diffusés.

ASPIRATIONS

Le Groupe de travail sur l'intégration terre/eau, qui entre dans sa troisième année, fait face à un certain nombre de problèmes qui exigent une solution et des mesures dans l'avenir immédiat. L'ordre du jour de la deuxième réunion nationale du CCCET comprend

un certain nombre d'ateliers du groupe de travail; ceux-ci seront un excellent forum où débattre les questions ci-dessous:

1. l'atelier n'a pas atteint son but. Certaines réserves ont même été manifestées quant à l'utilité d'un tel atelier. Etant donné la première réunion déjà tenue, la publication imminente de l'ouvrage de D. Welch et des échanges d'informations qui ont cours, que peut-on attendre d'autre d'un atelier en ce moment?

2. un atelier suscite toujours un intérêt et engendre des activités connexes. En l'absence d'un atelier, quelles sont les autres avenues permettant d'étendre la recherche sur les moyens de réalisation et l'objet de l'intégration?

3. il a été suggéré de produire un document technique, une sorte de sommaire préalable portant sur l'intégration terre/eau. Il pourrait être rédigé par une petite équipe et distribué pour examen et

4. la rédaction de lignes directrices ou de tout autre document technique doit se faire en collaboration avec les autres groupes de travail. En particulier les groupes de travail sur les terres humides et sur la méthodologie et la philosophie doivent être consultés de façon suivie. Quel est le meilleur moyen d'y parvenir?

REPORT ON THE ACTIVITIES OF THE NATIONAL WETLANDS WORKING GROUP

F. C. Pollett
Newfoundland Forest Research Centre
Canadian Forestry Service
St. John's, Newfoundland

INTRODUCTION

This is the first report of the National Wetlands Working Group. Its purpose is to outline the steps taken in Group organization and the current activity structure.

The Group has historical roots back to the fall of 1970. At that time a Subcommittee on Organic Terrain Classification was formed to function under guidance of the National Committee on Forest Land. This Subcommittee, under the chairmanship of Mr. S.C. Zoltai[1] was established to *'develop a system of organic terrain classification applicable for various land use purposes'*.

The classification system envisaged was to be compatible with the current methods of land resource surveying and suitable for end use in forestry, wildlife, hydrology, agriculture, recreation and engineering sectors. The types of terrain to be included in the study were not only organic but also other wetlands, regardless of the organic matter mantle.

With these broad terms of reference, the Subcommittee began its task, and as reported by Zoltai (1976), developed a tentative wetland classification system by 1973. After this achievement, the group became dormant.

In 1976, following the first meeting of the CCELC in Petawawa, an attempt was made to activate another Wetlands Working Group under the sponsorship of the CCELC. It was felt that this Working Group should continue much of the work initiated by the Subcommittee. In the fall of 1976 at the first meeting of the Working Group Chairmen, the goals of the Wetlands Working Group were discussed. It was decided that the long term goal should be *'to develop a healthy national prespective on the wetland resource and its potential uses'*. Other goals were:

- to improve the original wetland classification prepared by the Subcommittee on Organic Terrain Classification

- to establish a registry (open file form) of wetland types with the purpose of maintaining some uniformity for the classification system

- to prepare a library of illustrations (e.g. selected air-photos, slides, sketches) of wetlands that might be used for educational, training and liaison activities

- to identify our user groups and to ascertain how our data are being used

- to hold workshops for the Working Group

- another goal was to establish pilot projects within regions to test the applicability of the proposed wetland classification. (This goal would be left to regional initiatives.)

With this history and framework the organization of the new Working Group was begun in early 1977.

ORGANIZATION OF THE NWWG

Discussions were held by the Chairman with wetland scientists in centres across Canada. Based on this dialogue it became clear that a large number of changes in personnel and related R and D programs had taken place over the past five years. There are many 'new' persons now in the field of wetland research. Also there is a growing interest in Canadian

[1]S.C. Zoltai
Northern Forest Research Centre
Edmonton, Alberta, T6H 3S5

wetland research activities being expressed by international scientists, particularly those in the United States and northern Europe.

Following discussion with wetland scientists, the selection and recruitment of provincial co-ordinators was initiated. This recruitment has recently been completed and the members of the Group are listed in Table 1. Since that time one member, Dr. Tarnocai, has accepted a new appointment in Ottawa. He will remain a member of the Group with special responsibilities under Activity III - Registry of wetland types in Canada (as outlined below with list of activities).

In October 1977, the first workshop of the Group was held in Newfoundland with 11 delegates present. A reevaluation of goals and objectives was undertaken and a list of approved activities was completed. The workshop included two days in the field to visit various wetland types and to discuss local problems of classification. This experience proved quite valuable to all participants in achieving a better comprehension of such problems. It was agreed that future workshops should include similar field excursions.

The next step in organization is to broaden the Group's expertise by invitation of particular specialists to join as members without having a particular coordinating role within a province. The number of specialists would be limited to a maximum of five. It is hoped to have this phase of recruitment completed by summer 1978.

NWWG ACTIVITIES — 1978-1981

By early 1978 a list of activities was finalized and work initiated. These activities are as follows:

Activity I - Production of a book on the 'Wetlands of Canada'

Rationale: There is an increasing need to enhance public awareness of the nation's renewable resources. The wetlands of Canada constitute a major renewable resource and occupies some 12-15% of the land area. Yet there is very little material available on wetlands for use by a broad-based audience. The opportunity to meet this need can and should be taken by NWWG through the production of a generalized ecological-based book on bog, fen, marsh and other associated wetlands. The text will likely be aimed at a high school-first year university level. Hopefully, it will be of such a nature that it would have appeal to the public at large. The text would describe and profusely illustrate the ecological diversity of wetlands from east to west and from the arctic to temperate zones.

Schedule:

Winter 1977 - Mr. Zoltai would seek input from Group members on modification of the wetland region map for Canada (committees have been appointed in British Columbia and in the Atlantic region to work on the delineation of boundaries).

Spring-Summer 1978 - The Chairman would complete a mock-up model chapter; this would be sent to members for comment and would be used as a guide for contributors.

Fall 1978 - An outline of the book completed and sent to interested persons for comment.

Fall-Winter 1978 - Author selection finalized and provided with background materials.

Winter-Spring 1979-80 - Draft manuscripts of chapters completed.

(Summers 1979 and 1980 photographic materials will be obtained; photographer will be provided as a service to regions wherever required).

Fall-Winter 1980 - Manuscript reviewed and redrafted.

Spring 1981 - Manuscript completed and press ready.

Activity II - A Canadian symposium on wetlands

Rationale: In addition to focus on enhancement of public awareness, there is a need to provide a focus on recent initiatives taken in wetland research across Canada. Under the sponsorship of the NWWG - CCELC it is proposed that such a symposium be held at a selected central location such as Winnipeg. The theme of the symposium would centre around ecological research on wetlands.

Schedule:

Summer 1978 - The Chairman will meet with potential organizers of the symposium to try and obtain some agreement for facilities, financing, etc.

Fall 1978 - At the NWWG annual workshop, program details will be discussed and assignments

delegated. (A time schedule will be established leading to date of symposium, possibly fall 1980).

Activity IIa - A wetland classification for Canada

Rationale: An updated and modified version of the existing wetland classification (Zoltai et al 1973) has been requested by many wetland specialists. This will be presented as a special paper at the national wetland symposium.

Schedule:

October 1978 - The topic will be further discussed at the NWWG meeting wetland workshop. The remaining time schedule will be established at that time.

Activity III - Registry of wetland types in Canada

Rationale: Characteristic wetland forms tend to develop within Wetland Regions. They are readily recognized and mappable. There is a need to initiate and maintain a registry of wetland types and to periodically publish such information. For potential users this registry may reduce the confusion introduced into the literature by the use of so many wetland terms.

Schedule:

Summer-Fall 1978 - Dr. Tarnocai will develop the guidelines and format to be used in registration. (All Group members and any other interested persons will be given ample opportunity for input into development of the registry). Examples of types for registration will be presented at the NWWG annual workshop in October.

Activity IV-- Annual Workshops

Rationale: The annual NWWG Workshop is essential if the Group is to function in a meaningful fashion. It serves to review the year's actitivies; to plan new activities; to renew professional contacts; and to view wetland conditions in portion of the country.

Schedule:

Fall 1978 - The first annual meeting was held at St. John's and Gander, Nfld. At this meeting the present activity structure was devised and accepted.

Fall 1978 - The second annual meeting to be held at Saskatoon, Sask.

Activity V - User Questionnaire

Rationale: One of the main difficulties in coordinating a national group is the maintenance of correspondence with interested persons and institutions throughout the country. There is a need to develop a questionnaire(s) which can be used to obtain information from persons wishing to have input into the Group activities. Also to obtain information concerning user requirements. This kind of data will be necessary for planning future activities.

Schedule:

Summer 1978 - A questionnaire will be completed for use by regional coordinators in soliciting information from individuals and institutions on the CCELC wetlands mailing list.

Fall 1978 - The 'user requirement' questionnaire will be formulated at the Annual Workshop.

REFERENCES

Zoltai, S.C., F.C. Pollett, J.K. Jeglum and G.D. Adams. 1973. Developing a wetland classification for Canada. *in* Proc. 4th North Amer. Forest Soils Conf. (ed. by B. Bernier and C. H. Winget). Les Presses de L'Université Laval.

Zoltai, S.C. 1976. Wetland Classification. *in* Proc. 1st Meeting Can. Comm. Ecol. Land. Classif. (ed. by J. Thie and G. Ironside). Ecol. Land. Classif. Ser. No. 1. pp. 61-71. Lands Directorate, Environment Canada, Ottawa.

Table 1: National Wetlands Working Group

Newfoundland

Mr. E.D. Wells
Nfld. Forest Research Centre
P.O. Box 6028
St. John's, Nfld. A1C 5X8
Telephone: (709) 737-4813

Nova Scotia and P.E.I.

Mr. H.E. Hirvonen
Lands Directorate
P.O. Box 365
Halifax, N.S. B3J 2P8
Telephone: (902) 426-4196

New Brunswick

Mr. A.D. Smith
Canadian Wildlife Service
P.O. Box 1590
Sackville, N.B. E0A 3C0
Telephone: (506) 536-3025

Quebec

Mr. R. Zarnovican
Centre de recherches
forestières des Laurentides
C.P. 3800
Ste-Foy, Qué. G1V 4C7
Telephone: (418) 694-3957

Ontario

Mr. A.N. Boissonneau
Ontario Centre for Remote Sensing
Ministry of Natural Resources
880 Bay Street
Toronto, Ontario M5S 1Z8
Telephone: (416) 965-8411

Manitoba

Prof. J. Shay
Dept. of Botany, University of Manitoba
Winnipeg, Manitoba
Telephone: (204) 474-8880

Ottawa

Dr. C. Tarnocai
Soils Coordinator, Central Region
Land Resource Research Institute
Room 3022, Neatby Bldg.
Agriculture Canada
Ottawa, Ontario K1A 0C6
Telephone: (613) 994-9657

Saskatchewan

Dr. G.D. Adams
Canadian Wildlife Service
115 Perimeter Road
Saskatoon, Sask. S7N 0X4
Telephone: (306) 665-4087

Alberta and Northwest Territories

Mr. S.C. Zoltai
Northern Forest Research Centre
5320 - 122 Street
Edmonton, Alta. T6H 3S5
Telephone: (403) 435-7210

British Columbia and Yukon

Dr. E.T. Oswald
Pacific Forest Research Centre
506 West Burnside Road
Victoria, B.C. V8Z 1M5
Telephone: (604) 388-3811

Chairman

Dr. F.C. Pollett
Nfld. Forest Research Centre
P.O. Box 6028
St. John's, Nfld. A1C 5X8
Telephone: (709) 737-4682

RAPPORT DES ACTIVITÉS DU GROUPE DE TRAVAIL TERRES HUMIDES

F. C. Pollett
Centre de recherche des forêts de Terre-Neuve
Service Canadien des Forêts
St. John's, Terre-Neuve

INTRODUCTION

Ce rapport est le premier émanant du Groupe de travail national sur les terres humides. Il a pour but de souligner les étapes de l'organisation du groupe et la structure actuelle de ses activités.

Les origines du groupe remontent à l'automne 1970. A cette époque, un Sous-comité de classification des tourbières a été constitué et placé sous la direction du National Committee on Forest Land (comité national des terres forestières). Ce sous-comité, présidé par M.S.C. Zoltai[1], a pour but *d'élaborer un système de classification des tourbières applicable à diverses utilisations des terres.*

Le système envisagé devait être compatible avec les méthodes actuelles servant aux relevés des ressources des terres et convenir finalement aux secteurs de la foresterie, de la faune, de l'hydrologie, de l'agriculture, des loisirs et du génie. L'étude devait porter sur divers types de terrains, non seulement sur les tourbières mais également sur les terres humides, sans égard au manteau tourbeux.

Investi de ce vaste mandat, le sous-comité s'était mis à la tâche et, comme l'indique Zoltai en 1976, avait mis au point un système provisoire de classification des terres humides en 1973. Par la suite, le groupe est resté inactif.

En 1976, à la suite de la première réunion du CCCET à Petawawa, on a tenté de lancer un autre Groupe de travail sur les terres humides, parrainé par le CCCET. On a alors décidé de poursuivre dans une large mesure le travail entrepris par le sous-comité. Lors de leur première réunion, à l'automne 1976, les présidents des groupes de travail, ont étudié les objectifs du Groupe de travail sur les terres humides. Ils ont alors assigné au groupe l'objectif à long term *d'élaborer une perspective nationale saine relativement aux ressources des terres humides et de leurs utilisations éventuelles*, ainsi que les objectifs suivants:

- améliorer la classification précédente des terres humides, élaborée par le Sous-comité sur la classification des tourbières
- créer un registre (de type "fichier ouvert" des diverses sortes de terres humides, pour assurer l'uniformisation du système de classification
- créer une bibliothèque d'illustrations (par exemple photo aériennes, diapositives et dessins, choisis) relativement aux terres humides et pouvant servir à l'enseignement, à la formation et aux échanges
- déterminer les groupes d'utilisateurs internes et examiner l'usage qui est fait des données
- tenir des ateliers à l'intention du Groupe de travail et
- réaliser des projets-pilotes dans les régions, afin de vérifier l'applicabilité de la classification envisagée. (Cette tâche serait laissée à l'initiative des régions.)

C'est dans ce contexte, début 1977, qu'a été lancé le nouveau Groupe de travail.

ORGANISATION DU GTTH

Le président s'est entretenu avec les chercheurs dans le domaine des terres humides des différents centres du Canada. Le dialogue qui s'est ainsi établi a permis de constater qu'un grand nombre de changements étaient intervenus dans le personnel et dans les programmes reliés à la recherche et au développement au cours des cinq dernières années. Il y a maintenant beaucoup de nouvelles figures dans le domaine de la recherche en terres humides.

---

[1] S.C. Zoltai
Northern Forest Research Centre
Edmonton (Alberta) T6H 3S5

Par ailleurs, des scientifiques d'autres pays, en particulier des Etats-Unis et du Nord de l'Europe portent un intérêt croissant aux recherches canadiennes dans ce domaine.

A la suite de ces discussions avec les chercheurs, on a entrepris la sélection et le recrutement des coordonnateurs provinciaux. Le recrutement a pris fin récemment. Les membres du groupe sont énumérés au tableau 1. Depuis, l'un des membres, M. Tarnocai, a accepté un nouveau poste à Ottawa. Il reste néanmoins membre du groupe; on lui a en effet confié certaines tâches spéciales relativement à l'activité III intitulée "Registre des types de terres humides au Canada" (comme on peut le voir dans la liste ci-dessous).

Le premier atelier du groupe, tenue en octobre 1977, à Terre-Neuve, a réuni 11 délégués. Ceux-ci ont entrepris une réévaluation des objectifs et établi une liste de travaux approuvés. Ils se sont rendus même sur le terrain pendant deux jours, afin de visiter divers types de terres humides et de débattre les problèmes de classification locale. Cette expérience s'est révélée très utile pour tous les participants et leur a permis de mieux comprendre ce genre de problèmes. On a alors convenu d'inclure de telles excursions sur le terrain dans les ateliers à venir.

L'étape suivante consiste à élargir la compétence du groupe, en invitant certains spécialistes à s'y joindre sans qu'ils aient à jouer un rôle de coordination particulier pour une province. Le nombre de ces spécialistes serait limité à cinq. On espère que le recrutement sera terminé à l'été 1978.

ACTIVITÉS DU GTTH — 1978-1981

Début 1978, la liste d'activités suivante a été dressée et sa réalisation a été entreprise:

Activité I - Rédaction d'un livre concernant les terres humides au Canada

Raison: Il est de plus en plus indispensable d'éveiller le public à la question des ressources renouvelables du pays. Les terres humides sont une ressource renouvelable importante du Canada et occupent de douze à quinze pour cent du territoire. Cependant, dans ce domaine, il y a très peu de documentation pouvant faire l'objet d'une large diffusion. Le groupe devrait répondre à ce besoin en produisant un livre sur l'écologie générale des fondrières, des marécages, des marais et des autres terres humides. Cet ouvrage s'adresserait vraisemblablement aux collèges et à la première année d'université. Il faut, par ailleurs, espérer que son contenu sera de nature à intéresser le grand public. L'ouvrage devrait décrire et illustrer abondamment la diversité écologique des terres humides d'est en ouest du pays et de l'arctique aux zones tempérées.

Calendrier:

Hiver 1977 - M. Zoltai demandera aux membres du groupe leur avis quant à la modification de la carte des régions canadiennes de terres humides (des comités ont déjà été créés en Colombie-Britannique et dans la région atlantique, avec mission de tracer les limites de ces terres).

Printemps-été 1978 - Le président rédigera un chapitre modèle, qui sera envoyé aux membres pour commentaires et servira de guide aux collaborateurs.

Automne 1978 - Le premier jet du livre devrait être terminé et communiqué aux personnes intéressées afin qu'elles le commentent.

Automne-hiver 1978 - Le choix des auteurs devrait être terminé et la documentation pertinente communiquée.

Hiver-printemps 1979-1980 - Les manuscrits des chapitres doivent être terminés.

(Au cours des étés 1979 et 1980 le matériel photographique devrait être réuni; par ailleurs un photographe sera mis à la disposition des régions).

Automne-hiver 1980 - Les manuscrits seront révisés.

Printemps 1981 - Les manuscrits seront prêts pour l'impression.

Activité II - Symposium canadien sur les terres humides

Raison: Non seulement il faut éveiller l'intérêt du public relativement aux terres humides, mais il importe également de souligner les récentes initiatives de recherche dans le domaine prises au Canada. Il est proposé, par conséquent, de tenir un symposium à ce sujet sous l'égide du Groupe de travail national sur les terres humides et du CCCET dans un endroit central, par exemple Winnipeg. Il aurait pour ce sujet principal la recherche écologique dans le domaine des terres humides.

Calendrier:

Été 1978 - Le président doit rencontrer les organisateurs éventuels du symposium et chercher à s'entendre avec eux sur les installations, le financement, etc.

Automne 1978 - Lors de l'atelier annuel du Groupe de travail national sur les terres humides, les détails du programme seront débattus et les diverses tâches assignées. (Un calendrier doit alors être établi jusqu'à la date du symposium, qui pourrait être tenu à l'automne 1980).

Activité IIa - Classification des terres humides canadiennes

Raison: Plusieurs spécialistes des terres humides ont réclamé une nouvelle version à jour de la classification actuelle des terres humides (établie par Zoltai et d'autres auteurs en 1973). Cette question doit faire l'objet d'un mémoire spécial qui sera communiqué au symposium national sur les terres humides.

Calendrier:

Octobre 1978 - Cette question sera à nouveau débattue lors de l'atelier sur les terres humides organisé par le groupe. Le reste du calendrier sera fixé à cette occasion.

Activité III - Registre des diverses sortes de terres humides au Canada

Raison: Les formes caractéristiques de terres humides ont tendance à se développer dans les régions appropriées. Elles sont immédiatement repérables et peuvent alors faire l'objet de relevés cartographiques. Il est essentiel de créer et de tenir à jour un registre des diverses sortes de terres humides et d'en publier périodiquement les mises à jour. Ce registre peut contribuer à dissiper la confusion créée chez les utilisateurs éventuels par la multitude des termes utilisés dans la documentation scientifique sur les terres humides.

Calendrier:

Été-automne 1978 - M. Tarnocai doit établir les lignes directrices et le format du registre. (L'ensemble des membres du groupe, ainsi que toute personne intéressée, aura amplement l'occasion de se prononcer sur l'élaboration de ce registre). Des exemples des sortes de terres humides retenues dans le registre seront fournis lors de l'atelier annuel du groupe en octobre.

Activité IV - Ateliers annuels

Raison: Pour assurer un fonctionnement satisfaisant du groupe, l'atelier annuel est essentiel. Il permet de passer en revue les activités de l'année, d'arrêter les activités futures, de renouer les contacts professionnels et d'étudier les conditions des terres humides dans certaines parties du pays.

Calendrier:

Automne 1978 - La première réunion annuelle a eu lieu à St-John's et à Gander (Terre-Neuve). A cette occasion, la structure des activités a été élaborée et adoptée.

Automne 1978 - La deuxième réunion annuelle doit se tenir à Saskatoon, en Saskatchewan.

Activité V - Questionnaire de l'utilisateur

Raison: L'une des principales difficultés de la coordination d'un groupe national est d'assurer la correspondance avec les personnes et les institutions intéressées à travers le pays. Il y a lieu d'établir un ou des questionnaires pour obtenir des données de personnes désireuses de collaborer avec le groupe aussi bien que pour recueillir des informations sur les besoins des utilisateurs. Ce genre de données sera nécessaire pour planifier les activités à venir.

Calendrier:

Été 1978 - Un questionnaire sera rédigé afin d'aider les coordinateurs régionaux à se renseigner auprès des personnes et établissements figurant sur la liste de distribution du CCCET, qui s'intéressent aux terres humides..

Automne 1978 - Le questionnaire portant sur les besoins des utilisateurs sera élaboré lors de l'atelier annuel.

BIBLIOGRAPHIE

Zoltai, S.C., F.C. Pollett, J.K. Jeglum et G.D. Adams. 1973. Developing a wetland classification for Canada. Compte rendu du 4e Congrès nord-américain des sols forestiers (éd. par B. Bernier et C.H. Winget). Les Presses de l'Université Laval.

Zoltai, S.C. 1976. Wetland Classification Proceedings of the 1st Meeting. Comité canadien de classification écologique des terres. (édité par J. Thie et G. Ironside). Série de Classif. Ecol. Terr. Nº 1, pp. 61-71. Dir. Gen. Terres, Environnement Canada, Ottawa.

Tableau 1: Groupe de Travail National sur les Terres Humides

Terre-Neuve

M. E.D. Wells
Nfld. Forest Research Centre
P.O. Box 6028
St. John's (Nfld.)A1C 5X8
Téléphone: (709) 737-4813

Nouvelle-Écosse et Ile-du-Prince Édouard

M. H.E. Hirvonen
Lands Directorate
P.O. Box 365,
Halifax (N.S.) B3J 2P8
Téléphone: (903) 426-4196

Nouveau-Brunswick

M. A.D. Smith
Canadian Wildlife Service
C.P. 1590
Sackville (N.B.) EOA 3CO
Téléphone: (506) 536-3025

Québec

M. Richard Zarnovican
Centre de recherches
forestières des Laurentides
C.P. 3800
Ste-foy (Qué.) GIV 4C7
Téléphone: (418) 694-3957

Ontario

M. A.N. Boissonneau
Ontario Centre for Remote Sensing
Ministry of Natural Resources
880 Bay Street
Toronto (Ontario) M5S 1Z8
Téléphone: (416) 965-8411

Manitoba

Prof. J. Shay
Dept. of Botany, University of Manitoba
Winnipeg (Manitoba)
Téléphone: (204) 474-8880

Ottawa

Dr. Charles Tarnocai
Coordonnateur des sols, Région centrale
Institut de recherche sur les terres
Pièce 3022, Immeuble Neatby
Agriculture Canada,
Ottawa (Ontario) K1A OC6
Téléphone: (613) 994-9657

Saskatchewan

Dr. D.G. Adams
Canadian Wildlife Service
115 Perimeter Road
Saskatoon (Sask.) S7N OX4

Alberta et Territoires du Nord-Ouest

M. S.C. Zoltai
Northern Forest Research Centre
5320 - 122 Street
Edmonton (Alta.) T6H 3S5
Téléphone: (403) 435-7210

Colombie-Britannique et Yukon

Dr. E.T. Oswald
Pacific Forest Research Centre
506 West Burnside Road
Victoria (B.C.) V8Z 1M5
Téléphone: (604) 388-3811

Président

Dr. F.C. Pollett
Nfld. Forest Research Centre
P.O. Box 6028
St. John's (Nfld.) A1C 5X8
Téléphone: (709) 737-4682

REVISED WORKING PAPER ON METHODOLOGY/ PHILOSOPHY OF ECOLOGICAL LAND CLASSIFICATION IN CANADA*

J. S. Rowe
Department of Plant Ecology
University of Saskatchewan
Saskatoon, Saskatchewan

ABSTRACT

A Working Paper on the rationale for Ecological Land Classification, first circulated in June 1977, is here revised in the light of comments by 42 respondents. There is general agreement that ecological land surveys, integrating disciplinary knowledge of the biologic and earth sciences at various scales in a hierarchy, fill a need in current land use planning and management. The key to the placing of map boundaries is understanding of genetic processes and functional relationships in landscapes. Because the driving force at all levels is climate (exchanges of energy and materials), the underlying aim of each mapping and classifying exercise is the differentiation of important land surface regimes, both large and small.

RÉSUMÉ

Un document sur la raison d'être de la classification écologique du territoire a été distribué une première fois en juin 1977. Le présent rapport constitue la révision dudit document après étude des 42 commentaires reçus. Généralement, on convient que les études écologiques du territoire, qui font appel à des notions de biologie et des sciences de la terre et les organisent en système, répondent à un besoin pour ce qui est de la planification et de la gestion de l'utilisation des terres. L'art d'établir les limites d'un territoire relève d'une connaissance de la genèse et des interactions fonctionnelles des paysages. Quelle que soit la classe écologique, le climat (échanges d'énergie et de matériaux) demeure la force motrice, c'est pourquoi l'objectif sous-jacent de la cartographie et de la classification écologique consiste à différencier les types de territoire (grands ou petits). (Trad. Éd.)

INTRODUCTION

According to Newsletter No. 1 of the CCELC, the Methodology/Philosophy Working Group "will concern itself with the continued development of a uniform ecological (biophysical) approach to land classification in Canada. It is responsible for formulating a statement on the philosophy of ecological classification. Included should be consideration of the rationale and methodology, of the revision of existing guidelines, the clarification of the difference between classification units and mapping units, and the development of a more rigorous terminology and hierarchical classification structure".

'Ecological (biophysical) land classification' refers to an integrated approach to land survey in which areas of land are classified and mapped as ecosystems according to their ecological unity. The classification process includes the description, the comparison and the synthesis of data related to the biological and physical characteristics of the land. Methods usually rely on remotely sensed imagery from which units are delimited at various scales. This approach to land survey was originally termed 'Biophysical Land Classification'; however, in compliance with recommendations of a national meeting (CCELC, 1977), the term 'Ecological Land Classification' (ELC) was adopted. To avoid confusion, 'Biophysical' is being retained in parentheses for an interim period.

The context of objectives and uses for ELC remains the same; namely to develop a method of integrated survey that will provide units of land significant for resource use and conservation. Ecological surveys of land are proceeding in various parts of Canada, all more or less aimed at the same goals. A perennial and fundamental question is whether, in the interests of mutual understanding and support, there can be a shared rationale, terminology and methodology. Can there be common agreement as to what constitutes a logical, efficient ELC approach?

* A draft of this paper was first circulated in June, 1977.

This paper is an attempt to establish an acceptable rationale. Methodology is not stressed; it will follow naturally once the basic philosophical concepts are clarified.

NEED FOR ECOLOGICAL LAND CLASSIFICATION (ELC)

Ecosystems are not linear; they work by circularities, which is a way of saying that all parts are interactive. Man lives inside the earth's ecosystems using the various parts as resources, often unaware of their interconnectedness. He feeds on and is supported by the land environment. Therefore, an ecological appreciation of land is vital. From the ELC view, it is equally important to know the resources (of earth, air, water and biota) and to understand their interactions.

ELC aims to provide a system that expresses the interactive character of the land's components – the landforms, waterbodies, climates, soils, vegetation, animal communities, man. It also attempts to show the relationships between different areas of land, between small and large parcels, as parts and wholes, in a spatial hierarchy.

By its integrative approach, ELC provides basic information for a wide range of resources planners and users. There are two advantages: (1) planners, managers and other users deal with the same basic ecological units, (2) users are provided with ecological (relational) information that fosters an appreciation of the interlocking effects of multiple uses. Therefore, a comprehensive view of management constraints and opportunities ought to be more readily achieved. By the same token, ELC counteracts the separate resource approach to land survey and planning that frequently precipitates land use conflicts. Advantages also accrue to natural resource scientists, for ELC is a spur to interdisciplinary education. By establishing a common base to which all specialist studies are related, better understanding and communication result.

HISTORY OF ECOLOGICAL LAND CLASSIFICATION

From a gradual start a decade or so ago, ELC has steadily gained momentum all across Canada. One incentive has been the need for careful resource development, in the context of planning for land use and for environmental protection. Another has been the realization that sectorial surveys were simply not providing data in ways that allowed subsequent synthesis and environmental interpretation.

The history of ELC is a large subject.* Suffice it here to point out that G. Angus Hills and his associates provided both a philosophical basis and exemplary land inventories for parts of Ontario beginning early in the 1950s. Similar convergent systems developed elsewhere, such as those of the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO) land surveys and of the British Military Engineering Experiment Establishment (MEXE) terrain evaluations. They demonstrated the feasibility and utility of a team approach, bringing together earth scientists and biologists.

In the 1960s the National Committee on Forest Land stimulated biophysical classifications regionally at the same time that the Canada Land Inventory was encouraging their practical applications. The first '*Guidelines*" (Subcomm. Biophys. Land Class., 1969) were produced just prior to a number of major undertakings in the 1970s; the Mackenzie Valley Corridor survey, the James Bay development, the Polar Gas Pipeline survey. They furthered ELC approaches by bringing together in the field a wide range of earth science and biology interests. The results have been an increase both in professionalism in land classification and in mutual understanding between disciplines. This trend toward cooperative interdisciplinary studies is commendable; it can be strengthened by a shared and mutually accepted rationale that further integrates the disciplinary approaches.

ESSENTIAL ROLE OF MAPPING IN LAND CLASSIFICATION

It is possible to organize spatial data concerning land by simple reference points or grid blocks that do consitute a 'map' as such. However, ELC sets out to divide the earth's surface into significant areal units of various scales, each assumed to have a certain internal homogeneity and functional integrity. How this is done is rarely spelled out.

---

*A short historical outline *The development of Ecological (Biophysical) Land Classification in Canada* is available from Mr. E. Wiken, Lands Directorate, Environment Canada, Ottawa, Canada (published in Landscape Planning 4(1977): 273-282).

Procedures depending on experience, intuition and empathy with the subject matter, learned predominantly by association with an acknowledged master through osmosis, are sometimes designated 'artistic' rather than 'scientific'. By this definition, ELC is probably more art than science. However, the art too has its reasons and it is desirable, insofar as possible, to search out the logic-in-use of what has variously been called 'total site classification', 'biophysical classification' and now 'ecological land classification'. Possibly the following explanation is not too wide of the mark.

Unlike the earth and biology sciences that were earlier on the scene, ecological land inventory grew up clutching aerial photos in its hands and surrounded by thematic maps of soils, geology and climate. The availability of scaled representation of the earth's surface, especially stereoscopic air photos, facilitated the definition of land units at various scales, accompanied by catch-as-catch-can taxonomies. What distinguishes ELC from other earth science surveys, apart from their different objectives, is the lack of an agreed-on taxonomic system. However, although each ELC practitioner has his own classification (usually appearing as an appendage to a map), there is a consensus that the patterning of vegetation and soil to landform provides the logical framework.

The primacy of the mapping units is significant. It suggests that the prevalent methodology begins with a stratification of the land as viewed on variously scaled thematic maps and photo images. Doubtless, classifications based on prior experience are brought to the task, so that observations and expectations are compared from the start. In this way geographic units emerge, to be shuffled, grouped and regrouped according to perceived relationships, not only at the same scale level but also by reference to more inclusive and less inclusive neighboring areas (i.e. up and down the hierarchical scale). In G.A. Hills' expression, the "hazy wholes" solidify by iterative "to and fro" experiences. As the logical taxonomy forms in the operator's mind, it in turn influences the way map divisions are made. Problems of place and of spatial relationships, not readily managed in a formal taxonomy, are easily handled as the spatial (dimensional) aspect of map units.

Later, with experience gained, the taxonomy formulated for the various units of land may be formalized and used as a guide for seeking out map units in new terrain. Thus, for example, nine 'Land Types' within every 'Land System' could be postulated a priori by a taxonomy that combines 3 moisture regimes with 3 ecoclimatic regimes. But the essential methodology of ELC is mapping, yielding variously scaled divisions and subdivisions of landscape that provide data for (and are then influenced by) derivative taxonomies.

Confusion may result if the distinction is not drawn between 'map' units (and types) and 'taxonomic' units (and types). This is clarified later, when spatial map units (often heterogeneous because of scale) are compared to logical taxonomic units (homogeneous by definition). Each of the units of land delineated on maps is concrete and unique; all can, however, be classed in abstract map types, such as the jackpine/sand plain' type. Whether or not such map types correspond neatly to taxonomic types depends on the scale at which the landscape is viewed, determining the size of the 'basic homogeneous taxonomic unit'. The current focus in Canada on map units and types, rather than on development of a strict taxonomic system of units and types, parallels the first stages of the National Soil Survey and has numerous advantages. A good descriptive scheme and an agreed-on terminology are priority needs.

LAND CLASSIFICATION FROM ABOVE AND FROM BELOW

A large literature exists on classification as a purposeful human activity. It is generally agreed that we classify in order to make sense of the perceived world and of the ideas that go along with it. Classifications organize and simplify knowledge; they generate reference 'types' and provide the means of extrapolating what is known about any given unit to others of the same type. Numerous students of the subject have pointed out that there are two mutually related mental activities that usually enter into the formulation of classes:

(1) Agglomeration - Grouping things on the basis of their similarities so that classes are built up by aggregation 'from below'. A requirement is that they be sorted into groups by reference to characteristics considered typical (for example, by reference to type specimens in botanical taxonomy). Classes so formed can be agglomerated in higher categories or super-classes so that a hierarchy is formed.

(2) Division - Dissecting wholes into parts on the basis of differences, so that classes and units are arrived at by subdivision 'from above'. (Some purists call this 'logical division', reserving the term 'classification' for the first activity, 'from below'). A whole thing that is perceived to be heterogeneous or patterned is dissociated into a number of more homogeneous parts. If at each division a consistent use is made of differentiating criteria, the resulting hierarchy of categories can be as consistent and logical as classification 'from below'. The two activities, subdividing and aggregating, are separable only by analysis. In actuality they transact like the blades of scissors, together cutting up experience into understandable pieces. Thus in ELC, tentatively delineated map units are at first tentatively classified, and the classification then guides further delineation of map units whose characteristics and relationships firm up as the process goes on. Applied to such 'hazy wholes' as land ecosystems by practitioners with widely different backgrounds, it is small wonder that a variety of classifications has resulted.

KINDS OF PROPERTIES USED IN CLASSIFICATION

A key problem for land classifiers concerns the kinds of attributes or properties of land that enter into the mapping and classifying process. Four of importance are the following:

Observed* { (1) Inherent (morphologic)
(2) Contextual (spatial or chorologic)

Inferred { (3) Developmental (morphogenetic or chronologic)
(4) Functional (ecologic-physiologic)

(1) Inherent properties are observable, taxonomic, 'factual' characters by which for example, certain landforms are classified as 'dunes' on the basis of shape and materials. Such properties are morphologic, structural, anatomical. Like soil horizons and tree cover, they can be seen, described, agreed on.

*I am indebted to J.G. Speight for suggesting the 'observed-inferred' and the 'inherent-contextual' dichotomies.

(2) Contextual or spatial properties have to do with recognizeable patterns; they are also observable but their significance is not so much inherent as relational. For example, soil catenas (associations) and watershed basins are composed of a variety of spatially associated, functionally related profiles and landforms, respectively.

Note that relatedness-by-contiguity need not imply relatedness in inherent properties. The catena comprises *different* taxonomic soil series, and the watershed basin *different* landforms. However, contiguity usually reflects some degree of genetic and functional relatedness, past or present, active or inactive.

(3) Developmental properties are usually described as genetic, morphogenetic or chronologic. They are contextual in time and are inferred from a variety of evidence, chiefly from observed changes in inherent properties with the passage of time. The sequence of changes is then read into what is currently visible. The term 'esker' applied to a sinuous gravelly ridge calls up the historic circumstances of englacial streams. A 'climax' spruce forest calls up an appropriate chronosequence of successional stages that led to it and to which it is time related. In geomorphology, certain landforms are classed on similarities of genesis (transportation and deposition) as 'alluvium' or 'colluvium'. Note that in all these examples the things or stages that are related by genesis may be dissimilar in inherent properties, just as the caterpillar differs from the butterfly, the tadpole from the frog. However, once developmental stages and properties are recognized, then appropriate observed characters can be selected to identify the genetic ties.

(4) Functional properties express current relationships of energy and material exchanges both within land areas and between them. Like genetic properties they are also inferred, though perhaps more from the observed contextual than from the inherent morphologic characteristics. Regimes of moisture within units of land are inferred from vegetation, soil horizon development and topographic slope position. Externally they may be gauged by reference to surrounding regional regimes of watershed basins and slopes.

LAND CLASSIFICATION AND THE USE OF DIFFERENT PROPERTIES

It is obvious that land taxonomies must use observable properties if there is to be common understanding. However, it is the inferred processes and functions of landscape ecosystems that are important to land use. Therefore the most useful taxonomies rely on observed characteristics selected to reflect important processes of genesis and function. Morphology is thereby merged with genesis, spatial relationships with function. Consider next the values of the observable properties — the inherent and the spatial-contextual — in relation to 'from-below' and 'from-above' classifications.

Formal taxonomies stress the use of inherent properties in classifying from below. The classifier begins with entities or individual things and groups them in a hierarchy of classes that, in ascending order, reflects an increasing generality of within-class similarities and between-class dissimilarities. Thus in botanical taxonomy, individual plants are grouped in species, genera, families. In such strict taxonomies the higher classes are logically dependent on the individuals with which the classing starts. The individuals or units are 'given' data; the system does not create or discover them, it only groups them.

The situation is different with earth surface areas, with landscapes. Discrete units are not 'given'; therefore, a variety of land individuals can be cut out of the geographic continua at different scales for different purposes. The usual method is divisive, from above, providing units believed to have genetic and functional significance as signalled by particular spatial associations of observed features. The invention of units is a necessary procedure to which purely logical taxonomies, building classes from below, lend no assistance.

Suppose, for example, that a geomorphologist were to attempt a formal classification of landforms based only on inherent properties such as surface shape (elemental flats, convexities and concavities), attempting to build the system up from below. He would never arrive at the unit 'floodplain', for it is a pattern of spatially associated but unlike flats, convexities and concavities. *The unit known as floodplain only comes into existence through the understanding of a significant process.* Once identified, floodplains can of course be classified into different types. They can be analyzed into classifiable components such as point bars, levées and backswamps which in turn can be merged or 'regionalized' back into floodplains. But they cannot be discovered by simply merging categories of similar things, via the 'from below' taxonomy route.

The important point is that subdividing (classifying from above) so as to identify important functional units of the landscape is not only a legitimate approach to ELC but also an indispensable one. Study of aerial photos and thematic maps, combined with a lively sense of landscape process and the meaning of spatial patterns, provides the means for discrimination of land units at different scales. Application of logical taxonomies can then refine the recognition of wholes and parts.

Some of the confusion surrounding land classification results from an uncritical borrowing of ideas from biological taxonomy. A fundamental point is that biologists start with simple given units (individual plants and animals) whose forms and functional performances can be abstracted from their spatial milieu. Classification from below on the basis of inherent properties is therefore eminently sensible. By contrast, the earth's surface is not neatly divided into given pieces. Each unit that is recognized at whatever scale, is the creation of the mapper. Making individuals by cutting them out of the spatial continuum is a necessary activity, requiring good judgement as to the genetic and functional meanings of patterns perceived. Therefore it is useless to agonize over the lack of biology-type taxonomies for geographic phenomena. Greater rationality in ELC will not come via that route but from closer attention to the criteria by means of which units of land are delineated at the various scales required.

Canada Soil Survey procedures are instructive.* Associations of soils ('catenas') are recognized as patterned map units that have genetic significance (developed on one kind of surficial material) and functional-ecological significance (adjacent soil members are related by slope drainage and microclimatic regime). However, soil associations are not taxonomic units because they are heterogeneous at the working scale of soil survey; smaller, purer taxonomic units are

---

* *The Canadian System of Soil Classification.* 1978. Canada Soil Survey Committee. Agriculture Canada Publ. No.1646. 164 p.

recognized (Pedons and Series) from which, simply by assemblage of similar ones, associations cannot be built. In other words, associations or catenas are spatial rather than logical taxonomic constructs. The same is true of zones and regions. On the other hand, the recognized higher taxonomic units (Family, Subgroup, Great Group, Order) have uneven genetic and functional significance. They are useful in simplifying and summarizing soils knowledge, but they contribute little to the mapping and understanding of soils.

CRITERIA FOR IDENTIFYING AND BOUNDING ELC UNITS

To map out and compare ecological units of land on aerial photos is to classify by subdivision in a very practical way. If the mapping is to be understandable by others, reasons must be given for the boundary placements. Sometimes a mapper will divide the landscape image according to differences in tone and texture, without understanding the nature of the units so differentiated. However, unless he goes on to discover their meaning, his map will have little value. The most useful maps are those expressing the logical and consistent use of explicit criteria, the latter developed during the course of field sampling and mapping. Such ones are both understandable and explanatory; they are open to criterial examination and improvement.

The argument has previously been made that important ecological land units are conceptualized and recognized as expressing genetic (developmental) and functional processes. From 'mental maps' of significant features, classifiers find their genetic and functional units under the stereoscope, on maps and in the field. These can then be described by inherent properties and categorized, sharpening up the conception of what constitutes 'good units'. The question of boundary criteria therefore comes back to *indicators* and *generators* of function and process in the landscape.

Concerning indicators, landscape ecosystems are composed of an air layer and an earth or water layer, with organisms sandwiched at the energized interface. All components are equally important and indispensable to the functioning of ecosystems. It is sometimes argued that, because all components are essential, it is only a matter of personal taste as to which among biota, soils, landforms and water bodies is selected to identify the kinds of ecological land units found in any area, as well as to decide where one type changes to another (the boundaries). The drawback to such a 'dealer's choice' is that it leads to numerous different classifications of unequal efficiency, each narrow and thematic in appearance if not in fact, distracting from the desirable goal of an interdisciplinary ecological approach

Perhaps the solution is to look for indicators (visible on air photos and on the ground) that can be identified with generators of function and process in various sized units of land. By this route we come to climate as the prime ecosystem motivator, indicated at various scales (regional to local) by readily perceivable vegetation-landform-drainage (water) patterns. How such patterns are used, and what priority and weight the components are given, will depend in part on terrain and on the scale of the study.

Classifiers agree that in a hierarchical system the differentiating criteria at the top levels (e.g. those used to establish large regional units) ought to be broad and general in importance, with the greatest integrative power, while those at low levels (e.g. for establishing local units) ought to be narrower and more specific in importance. By "importance" is meant relevant to the objectives of the classification as well as correlated with other significant properties. Thus several guidelines are provided for selecting the most useful relational criteria to identify and bound ELC units at all levels.

AN EXAMPLE

Classification 'from below' cannot by itself discover significant ecological land units. They must be apprehended as wholes that have some morphogenetic or ecological-functional significance. As examples, consider four common units from large to small:

(1) <u>Ecoregion (Land Region)</u> — A macroclimatic unit where, at present, all landscape processes participate in one type of major regime. Boundaries are established by reference to macro biota-soil indicators of latitudinal and longitudinal climatic change.

(2) <u>Ecodistrict (Land District)</u> — A subregional unit where, due to influences of altitude (relief) and/or geological substratum, the climatic regime differs substantially from adjacent lands. For example, the Land District of a high plateau may represent an outlier of a

more northern Land Region. Boundaries are set by reference to macro changes in relief and/or bedrock geology.

(3) Ecosection (Land System) — An intermediate sized unit whose form expresses a climatic-geomorphologic process (fluvial, colluvial, aeolian, glacial, etc.). Examples are hummocky moraine landscape, coarse stratified drift landscapes, etc. Boundaries are set by reference to meso changes in surficial geology and landform.

(4) Ecosite (Land Type) — A small topographic unit, one of the associated catenary members of a Land System, uniform in the functionally related local climate, soil drainage and biota. Boundaries are set by reference to changes in slope and in variations of soil materials and depth.

The preceding example, assigning prime importance at the different scale levels to biota, to soil, to relief, etc., needs a caveat. Although specific biotic indicators and physiographic controls can be particularly useful at specific levels of ELC, they also are useful when suitably generalized at other scales. For example, the broad physiognomic character of vegetation that reflects regional climate (level 1) is vastly different from the species composition and abundance that reflects local climate (level 4). Although relief may be important in demarcating 'districts' (level 2), it also enters into the discrimination of 'section systems' (level 3) through landform-topography expression. Geology is of variable importance at different levels; it may provide the basis for defining large areas (levels 1 and 2) while also providing clues to the distribution of soil parent materials (levels 3 and 4).

Although the levels can often be mapped by reference to single physiographic and biologic features, there must always be check-back to assure that boundaries have ecological significance. A climatic map showing such key factors as temperature and precipitation is not an ecological map, *until* its boundaries are shown to correspond to significant biologic boundaries. A geomorphologic map showing such controlling features as surficial materials and topography is not an ecologic map, *until* some correspondence between its landforms and vegetation-soils has been established. Maps of vegetation and soils are not necessarily ecological maps, *until* it is shown that the types covary with physiographic features and are not simply accidents and 'hang overs' from different environments of the past.

It is not suggested in the foregoing that four levels of land classification are everywhere desirable; there could be two or twelve, so long as legitimate purposes are thereby served. However, it is advantageous to have a basic framework consisting of a relatively few units (whatever they may be called) to which all land classifiers can relate and between which other units can be interpolated as required.

SUMMING UP

Although some commonality of ideas exists at present, there is no uniform approach to ELC. To find common ground, the logic of every system ought to be spelled out, at least to the extent that its concepts are defined and its units of land are bounded by reference to specified components and criteria. Some influential people in ELC have already systemized their work and this paper implies no criticism of them. However, the recent upswing in ELC across Canada has brought many new teams to the field and the time is appropriate to call for a critical look at the basics, plus a nation-wide effort to maximize understanding of this important endeavour.

The request for input from interested people is repeated. Criticism of this revised paper, with constructive ideas as to how the philosophy and methodology can be clarified, will be appreciated. Although this has been a joint endeavour, it by no means represents a consensus of those who have contributed. Hopefully it is a step toward that goal.

ACKNOWLEDGEMENTS

Assistance of numerous people who commented on the first draft (circulated 1977) is gratefully acknowledged. With no implication that they subscribe fully to the present revision, their names are listed below.

Australia: R.H. Gunn, J.G. Speight, R. Story
U.K.: R.G.H. Bunce, M.F. Thomas
U.S.A.: R.J. Alvis, R.G. Bailey
J.M. Crowley, C. Hutchinson
R.D. Pfister, C.J. Robinove
Canada: R.E. Bailey, A. Boissonneau
J.W. van Barneveld, W.A. Celentino
A. Crowder, D. Day, P.J.B. Duffy
W.A. Fuller, R.J. Fulton, I. Gillies
F.B. Goldsmith, D.L. Handley, J. Jeglum
M. Jurdant, A. Kosowan, P. Kumar

J.D.H. Lambert, A. Moss, J.G. Nelson
J.J. Nowicki, P. Ojamaa, W.W. Pettapiece
R. Revel, R.A. Ryerson, A. Schori
R. Starling, W.R. Stephenson, P.E.K. Symons
J. Thie, D. Welch, E. Wiken

DOCUMENT DE TRAVAIL REVISÉ SUR LA MÉTHODOLOGIE/ PHILOSOPHIE DE LA CLASSIFICATION ÉCOLOGIQUE DU TERRITOIRE AU CANADA

J.S. Rowe
Département de l'écologie des plantes
Université de Saskatchewan
Saskatoon, Saskatchewan

RÉSUMÉ

Un document sur la raison d'être de la classification écologique du territoire a été distribué une première fois en juin 1977. Le présent rapport constitue la révision dudit document après étude des 42 commentaires reçus. Généralement, on convient que les études écologiques du territoire, qui font appel à des notion de biologie et des sciences de la terre et les organisent en système, répondent à un besoin pour ce qui est de la planification et de la gestion de l'utilisation des terres. L'art d'établir les limites d'un territoire relève d'une connaissance du genre et des interactions fonctionnelles des paysages. Quelle que soit la classe écologique, le climat (échanges d'énergie et de matériaux) demeure la force motrice, c'est pourquoi l'objectif sous-jacent de la cartographie et de la classification écologique consiste à différencier les types de territoire (grands ou petits).
(Trad. Éd.)

ABSTRACT

A Working Paper on the rationale for Ecological Land Classification, first circulated in June 1977, is here revised in the light of comments by 42 respondents. There is general agreement that ecological land surveys, integrating disciplinary knowledge of the biological and earth sciences at various scales in a hierarchy, fill a need in current land use planning and management. The key to the placing of map boundaries is understanding of genetic processes and functional relationships in landscapes. Because the driving force at all levels is climate (exchanges of energy and materials), the underlying aim of each mapping and classifying exercise is the differentiation of important land surface regimes, both large and small.

INTRODUCTION

Le Bulletin d'information N° 1 du Comité indique que le Groupe de travail sur les méthodes/philosophie s'intéressera à l'élaboration continue d'une méthode écologique (biophysique) de classification des terres du Canada. Ce groupe sera chargé de rédiger un rapport sur les concepts de classification écologique qui traitera des principes et des méthodes, de la révision des lignes directrices existantes, des différences qui existent entre les unités de classification et les unités cartographiques et de l'établissement d'une terminologie et d'une structure hiérarchique plus rigoureuses.

L'expression 'classification écologique (biophysique) du territoire' désigne une méthode intégrée de levé des terres qui consiste à représenter et à classer des zones qui, par leur unité écologique, forment un écosystème. La classification comprend la description, la comparaison et la synthèse des données sur les caractéristiques biologiques et physiques du territoire. Elle se fait généralement à partir d'images fournies par télédétection qui permettent de délimiter les unités à différentes échelles.

A l'origine, ce type de levé des terres était désigné sous le nom de 'classification du territoire'. Toutefois, à la suite de recommandations faites au cours d'une réunion du Comité en 1977, l'expression "classification écologique du territoire" (CET) a été adoptée. Afin d'éviter toute confusion, le terme "biophysique" sera indiqué entre parenthèses pendant un certain temps.

Les objectifs et les utilisations de la CET sont toutefois les mêmes, soit élaborer une méthode de levé intégré qui permettra de délimiter des zones en fonction de l'utilisation et de la conservation des ressources. L'étude écologique du territoire est en cours dans plusieurs régions au Canada, avec des objectifs plus ou moins semblables. On se demande toutefois si, dans l'intérêt d'une meilleure compréhension et d'une aide mutuelle, il ne conviendrait pas d'établir des principes, une terminologie et une méthodologie communes. Est-il possible d'élaborer une méthode logique et efficace de classification des terres qui

* Une copie provisoire de ce rapport a été distribuée en juin 1977

convienne à tous? Le présent document tentera d'établir des principes acceptables. La méthodologie n'est pas précisée, elle suivra naturellement une fois les concepts de base établis.

NÉCESSITÉ D'UNE CLASSIFICATION ÉCOLOGIQUE DU TERRITOIRE (CÉT)

Les écosystèmes ne sont pas linéaires mais circulaires, c'est à dire que tous leurs éléments sont interdépendants. L'homme vit dans ces écosystèmes dont il exploite les ressources, sans souvent connaître les relations qui existent entre elles. La nature le nourrit et subvient à ses besoins. Une évaluation écologique des terres afin de connaître les ressources (sol, air, eau et biote) et leurs intéractions. La CET vise à servir de système permettant de définir les relations qui existent entre les éléments d'une zone, soit le relief, les étendues d'eau, le climat, les types de sol, la végétation, la faune et l'homme. Elle tente également de préciser les relations entre les différentes régions, les petites et les grandes parcelles de terrain considérées en tant que partie et tout, selon une hiérarchie géographique. Par son approche intégrée, la CET fournit des données de base à de nombreux planificateurs et utilisateurs des ressources.

L'avantage qu'elle présente est double: (1) les planificateurs, les aménageurs et les autres utilisateurs emploient les mêmes unités écologiques de base, (2) ils reçoivent des renseignements écologiques (relatifs) qui leur donnent une idée des effets interdépendants de l'utilisation multiple des terres. Par conséquent, l'évaluation globale des contraintes et des possibilités de gestion devrait être plus facile à réaliser. De plus, la CET permettra d'éviter les utilisations incompatibles qu'entraînaient les méthodes de levé et de planification selon les ressources distinctes. Elle profite également car elle favorise des études interdisciplinaires. Grâce à cette base interdisciplinaire, une meilleure compréhension et une meilleure communication sont possibles.

HISTORIQUE DE LA CLASSIFICATION ÉCOLOGIQUE DU TERRITOIRE

Depuis ses débuts, il y a dix ans environ, la classification écologique du territoire a évolué à un rythme de plus en plus rapide sous l'impulsion de la mise en valeur des ressources, dans le contexte de la planification de l'utilisation des terres et de la protection de l'environnement. En outre, les chercheurs ont réalisé que les études sectorielles ne permettaient pas de faire une synthèse et une interprétation du milieu.

L'historique de la classification écologique du territoire constitue un vaste sujet.* Il suffit de souligner que G. Angus Hills et ses collaborateurs ont fourni à la fois une base conceptuelle et des inventaires types de terres pour certaines parties de l'Ontario au début des années 50. Des systèmes convergents similaires ont été élaborés ailleurs, notamment celui de l'Australian Commonwealth Scientific and Industrial Research Experiment Establishment (MEXE); ils ont démontré la faisabilité et l'utilité du travail collectif d'une équipe de spécialistes des sciences de la terre et de biologistes.

Dans les années 60, le Comité national des terres forestières a encouragé l'établissement de classifications biophysiques au niveau régional tandis que le programme de l'Inventaire des terres du Canada encourageait leur application pratique. Les premières *Guidelines* (Sous-comité de la classification biophysique des terres, 1969) ont précédé de peu plusieurs grandes entreprises des années 7 soit l'étude du corridor de la vallée0, du Mackenzie, l'aménagement de la baie James, le tracé du pipeline Polar Gas. En réunissant de nombreuses données sur les sciences de la terre et sur la biologie, elles étaient dans la ligne des méthodes de classification écologique. Cela a donné lieu à un professionnalisme accru dans le domaine de la classification écologique et à une compréhension mutuelle entre les diverses disciplines. Cette tendance vers des études collectives multidisciplinaires est louable et peut-être renforcée par des principes communs acceptés de tous favorisant les méthodes intégrées.

RÔLE ESSENTIEL DE LA CARTOGRAPHIE DANS LA CLASSIFICATION DU TERRITOIRE

Il est possible d'organiser les données sur les terres par simple référence aux coordonnées ou aux quadrilatères qui constituent les cartes. Toutefois, la classification écologique permet de diviser la surface de la terre en unités géographiques significatives à diverses échelles, chacune ayant présumément une certaine cohésion et une certaine indépendance. La façon de le faire est rarement expliquée.

* Le bref historique intitulé *The development of Ecological (Biophysical) Land Classification in Canada* peut être obtenue en s'adressant à M. Ed. Wiken, Direction générale des terres, Environnement Canada, Ottawa (publié dans le Landscape Planning 4, (1977): 272-282).

Les méthodes qui reposent sur l'expérience, l'intuition et la connaissance intuitive du sujet et qui sont apprises par osmose d'un maître réputé sont ordinairement qualifiées d'"artistiques" plutôt que de "scientifiques". D'après cette définition, la classification écologique du territoire est davantage un art qu'une science. Toutefois, l'art a aussi son utilité et peut servir, dans la mesure du possible, à analyser la logique inhérente à ce qu'on a appelé la 'classification totale des stations' et la 'classification biophysique' qu'on appelle maintenant 'classification écologique du territoire'. L'exposé qui suit se rapproche beaucoup de cet objectif.

Contrairement aux études relatives aux sciences de la terre et à la biologie, l'inventaire écologique du territoire a commencé à l'aide de photos aériennes et de cartes thématiques des sols, de la géologie et du climat. Les représentations de la surface terrestre à l'échelle, notamment les photos aériennes stéréoscopiques, ont permis de définir des unités écologiques classées sans règles bien précises à diverses échelles. Outre ses objectifs différents, la classification écologique du territoire se distingue des autres levés par l'absence de système de classification commun. Toutefois, bien que chaque taxonomiste ait son propre système (généralement indiqué en annexe d'une carte), les caractéristiques de la végétation et du sol en fonction du relief forment le critère logique adopté par tous.

La primauté des unités cartographiques est révélatrice. Elle indique que la méthode la plus utilisée commence par la stratification du terrain telle qu'elle apparaît sur des cartes thématiques et des photographies à diverses échelles.

Les classifications établies précédemment sont évidemment analysées en vue de comparer les observations et les estimations dès le départ. De cette façon, les unités géographiques reconnues sont permutées, groupées et regroupées d'après les relations perçues non seulement au même niveau hiérarchique mais aussi par rapport aux zones avoisinantes plus ou moins complètes (c'est à dire le long de l'échelle hiérarchique). Selon G.A. Hills, ces agencements "to and fro" permettent de préciser les "hazy wholes". Si la classification logique est découverte par le chercheur, elle influence par ailleurs le mode de découpage des terres sur les cartes. Les problèmes de place et de relation spatiale, difficilement incorporés dans un système de classification rigide, sont facilement traités en tant qu'aspect géographique (dimensionnel) des unités cartographiques.

Plus tard, avec l'expérience, la classification adoptée pour les différentes unités écologiques peut être acceptée officiellement et servir de guide pour délimiter les unités cartographiques de nouveaux terrains étudiés. Ainsi, on peut supposer a priori neuf 'types écologiques' dans chaque 'système écologique' lorsque la classification comprend trois régimes hygrométriques et trois régimes écoclimatiques. La cartographie constitue toutefois la méthode essentielle de la classification écologique du territoire; elle permet d'établir des divisions et des subdivisions à différentes échelles qui fournissent des données pour des classifications secondaires logiques susceptibles de les modifier à nouveau.

Une certaine confusion peut naître si aucune distinction n'est faite entre les unités (et types) 'cartographiques' et les unités (et types) 'taxononiques'. La précision sera donnée plus loin, lorsque les unités cartographiques (souvent hétérogènes en raison de l'échelle utilisée) seront comparées aux unités taxonomiques logiques (homogènes par définition). Chaque unité géographique délimitée sur les cartes est particulière et unique; toutes cependant peuvent être classées par type abstrait comme le type 'pin gris/ plaine de sable'. La correspondance entre les types cartographiques et les types taxonomiques dépend de l'échelle utilisée, laquelle détermine la grandeur des 'unités taxonomiques homogènes de base'. L'intérêt particulier du Canada pour les unités et les types cartographiques plutôt que pour un système de classification rigide rappelle les premières étapes de l'Inventaire national des sols et offre de nombreux avantages. L'établissement d'un bon plan descriptif et d'une terminologie acceptée par tous constitue la principale priorité.

CLASSIFICATION DU TERRITOIRE PAR DIVISION ET PAR GROUPEMENT

Il existe une vaste documentation sur la classification en tant qu'activité humaine délibérée. Nous convenons généralement que la classification permet d'orienter notre perception du monde et les notions qui l'accompagnent. Elle permet de structurer et de simplifier nos connaissances, d'établir des types de référence et d'extrapoler ce que nous savons d'une unité donnée pour d'autres unités du même type. Nombreux sont ceux qui, ayant étudié le sujet, ont souligné l'existence de deux activités mentales interreliées qui permettent ordinairement d'établir des classe, soit:

(1) Le groupement - C'est à dire le groupement de choses d'après leurs similitudes de telle sorte que les classes sont formées par groupements d'éléments. Il faut toutefois que ces derniers soient groupés d'après leurs caractéristiques types (par exemple, d'après les spécimens types en taxonomie botanique). Les classes ainsi formées peuvent être groupées pour former des catégories ou des classes supérieures de façon à constituer une hiérarchie.

(2) La division - C'est à dire la division des ensembles en parties selon les différences de telle sorte que les classes et les unités sont formées par subdivision à partir d'un tout. (Certains puristes donnent à ce processus le nom de 'division logique' et réservent celui de 'classification' à la première activité, le groupement.) Un ensemble perçu comme hétérogène ou composé est divisé en un certain nombre de parties plus homogènes. Si, à chaque division, les critères de différenciation sont utilisés de manière systématique, la hiérarchie des catégories obtenue peut être aussi uniforme et logique que la classification par groupement. Les deux activités, division et groupement, ne sont séparables que par analyse. En fait, elles se complètent comme les lames d'un ciseau qui couperaient l'expérience en parties que l'intelligence peut saisir. Ainsi, dans la classification écologique du territoire, les unités cartographiques délimitées provisoirement sont d'abord classées à titre provisoire, et la classification obtenue aide alors à faire une délimitation plus exacte des unités dont les caractéristiques et les relations se précisent au fur et à mesure. Avec des ensembles aussi flous que les écosystèmes terrestres etla diversité des antécédents des taxonomistes, il n'est pas étonnant que de nombreuses classifications aient vu le jour.

PROPRIÉTÉS UTILISÉES POUR LA CLASSIFICATION

Les types d'attributs ou de propriétés des terres qui guident le processus de cartographie et de classification constituent le problème majeur auquel se heurtent les spécialistes de la classification. Il existe quatre propriétés importantes:

Observées *{ 1) inhérentes (morphologiques)
2) contextuelles (spatiales ou chronologiques

Déduites { 3) évolutives (morphogénétiques ou chronologiques
4) fonctionnelles (écologiques et physiologiques)

(1) Les propriétés inhérentes sont des caractéristiques taxonomiques observables et concrètes d'après lesquelles certaines configurations sont classées comme des 'dunes' selon les formes et les matériaux qui les composent. Ces propriétés sont morphologiques, structurales et anatomiques. Certaines peuvent être observées, décrites et classées, comme les horizons du sol et le couvert forestier.

(2) Les propriétés contextuelles ou spatiales se rapportent à des modèles facilement reconnaissables; elles peuvent être observées, mais leur importance n'est pas tant inhérente que relative. Par exemple, les chaînes de sol (associations) et les bassins versants regroupent, respectivement, de nombreux profils et reliefs associés dans l'espace et interreliés.

Il faut remarquer que la connexité par contiguïté ne signifie pas nécessairement une connexité des propriétés inhérentes. Ainsi, la catena de sols comprend séries taxonomiques *différents* de sols et le bassin versant, et reliefs *différents*. Par ailleurs, la contiguïté reflète généralement un certain degré de connexité génétique et fonctionnelle, présente ou passée, active ou inactive.

(3) Les propriétés évolutives sont généralement génétiques, morphogénétiques ou chronologiques. Elles sont contextuelles et expriment les relations temporelles du changement des propriétés inhérentes. La série de changements est ensuite insérée dans un schéma visible. Le terme 'esker' appliqué à un remblai sinueux formé de graviers sous-entend le processus d'infiltration des cours d'eau sous les glaciers. Une forêt 'climax' d'épinettes amène une chronoséquence des stades et de successions. En géomorphologie, certains reliefs sont classés d'après la similitude de leur genèse (transport et dépot) comme des 'alluvions' ou 'colluvions'. Il faut remarquer que dans ces exemples, les éléments classés d'après leur connexité génétique ou évolutive sont parfois dissemblables par leurs propriétés inhérentes, tout comme la chenille se distingue du papillon et le têtard de la

---

* Je suis endetté à J.G. Speight pour la suggestion des termes "observées-déduites" et inhérentes-contextuelles".

grenouille. Néannoins, une fois le processus évolutif et les propriétés reconnus, les caractéristiques appropriées peuvent être choisies en vue d'identifier leurs liens génétiques.

(4) Les propriétés fonctionnelles expriment les relations des échanges d'énergie et de matériaux qui existent dans les écosystèmes terrestres et entre eux. Tout comme les propriétés génétiques, elles sont déduites mais à partir des propriétés contextuelles observées plutôt que des propriétés morphologiques inhérentes. Les régimes hygrométriques sont déduits d'après la végétation, le développement des horizons du sol et la pente topographique. Extérieurement, ils peuvent être mesurés en fonction des bassins versants et des pentes environnants.

CLASSIFICATION DU TERRITOIRE ET UTILISATION DES PROPRIÉTÉS DIFFÉRENTES

Il est évident que les classifications du territoire doivent se faire en fonction de propriétés observables pour être comprises par tous. Toutefois, dans le cadre de l'utilisation des terres, ce sont le processus et les fonctions déduits des écosystèmes paysagers qui importent le plus. Les classifications les plus utiles reposent donc sur les caractéristiques observées choisies pour refléter les processus génétique et fonctionnel. La morphologie est ainsi associée à la genèse, et les relations spatiales au processus fonctionnel. Les paragraphes suivants sont consacrés à la valeur des propriétés observables (propriétés inhérentes, spatiales et contextuelles) par rapport aux classifications par 'groupement' et par 'division'.

Les classifications rigides mettent l'accent sur la classification par groupement à l'aide des propriétés inhérentes. Le taxonomiste commence avec des entités déjà définies (ou données) et les groupes selon une hiérarchie des classes qui reflète une généralité croissante des similitudes à l'intérieur des classes et des dissemblances qui existent entre elles. Ainsi, dans la taxonomie botanique, les plantes sont groupées par espèce, par genre et par famille. Dans de telles classifications, les classes supérieures dépendent logiquement des unités et des renseignements donnés; le système ne les crée ni ne les découvre: il ne fait que les grouper.

La situation est différente en ce qui concerne les unités géographiques de surface, telles que les zones écologiques. Les unités discrètes ne sont pas 'données'. Pour cette raison, la méthode habituelle consiste à diviser des continua en formant des unités ayant une importance génétique et fonctionnelle révélée par des associations spatiales particulières des propriétés observées. La création d'unités par découpage du continuum est un procédé nécessaire pour lequel les classifications purement logiques par groupement, ne sont guère utiles.

Supposons par exemple, qu'un géomorphologue tente de faire une classification rigide par groupement des formes du terrain en se basant seulement sur les propriétés inhérentes comme la forme de la surface (plaines, convexités et concavités élémentaires). Il n'arrivera jamais à l'unité 'plaine d'inondation', car il s'agit d'une association spatiale de plaines, de convexités et de concavités différentes. *L'unité plaine d'inondation exige pour être reconnue la connaissance d'un processus distinct.* Une fois identifiées, les plaines d'inondation peuvent, bien sûr, être classées par différents types ou analysées afin de connaître leurs composantes que l'on peut classer, comme les bourrelets arqués, les levées naturelles ou les dépressions latérales, qui à leur tour peuvent être réunies pour former les plaines d'inondation. Toutefois, elles ne peuvent être découvertes en groupant simplement les catégories d'éléments semblables à l'aide de la classification par groupement.

La classification par division n'est pas seulement valable pour identifier les unités fonctionnelles importantes, mais elle est aussi indispensable. L'étude des photos aériennes et des cartes thématiques combinée à la connaissance du processus à l'intérieur des paysages et à la signification des modèles spatiaux permet de distinguer les unités écologiques à diverses échelles. L'utilisation des classifications logiques permet ensuite de préciser les unités entières et partielles.

Une part de la confusion associée à la classification du territoire vient de l'emprunt abusif de notions propres à la taxonomie biologique. Or, les biologiste part d'unités données simples (plantes et animaux individuels) dont les formes et les caractéristiques fonctionnelles peuvent être examinées, indépendamment de leur environnement géographique. La classification par groupement basée sur les propriétés inhérentes est donc très appropriée. Par contre, les phénomènes géographiques ne sont pas distincts ou dissociables. Chaque unité, peu importe l'échelle, est créée par le cartographe. Cette création d'unités par le découpage du continuum géographique est nécessaire et demande une bonne interprétation génétique et fonctionnelle des formes perçues. Il est donc inutile de se plaindre de l'absence de taxonomies de type biologique pour les phénomènes géographiques. Une plus grande rationalité

dans le système de classification écologique ne s'obtiendra pas de cette manière mais en portant un plus grand intérêt aux critères qui servent à délimiter les unités écologiques, aux différentes échelles requises.

Les procédés employés par la Commission canadienne de pédologie sont instructifs. * Les associations de sols (caténas) sont décrites comme des unités cartographiques figurées ayant une importance génétique (basée sur un type de matéria superficiel) et une importance écologique et fonctionnelle (les éléments adjacents du sol sont reliés par le drainage en pente et par le régime microclimatique). Toutefois, les associations de sols ne sont pas des unités taxonomiques car elles sont hétérogènes à l'échelle utilisée pour l'étude des sols; néanmoins, certaines unités taxonomiques plus pures et plus petites sont observées (pédons et séries) mais il est impossible de faire des associations en regroupant uniquement les unités similaires. En d'autres termes, les associations ou chaînes sont des unités géographiques plutôt que des unités taxonomiques logiques. Il en est de même pour les zones et les régions. Par ailleurs, les unités taxonomiques supérieures reconnues (famille, sous-groupe, groupe et ordre) ont une importance génétique et fonctionnelle inégale. Elles sont utiles pour simplifier et résumer les connaissances sur les sols, mais n'aident ni à cartographier des sols ni à en obtenir une meilleure compréhension.

CRITÈRES DE L'IDENTIFICATION ET DE LA DÉLIMITATION DES UNITÉS DE CLASSIFICATION ÉCOLOGIQUE

La délimitation et la comparaison des unités écologiques sur des photos aériennes constituent une méthode de classification par division très pratique. Pour que la carte puisse facilement être lue, il faut justifier l'emplacement des limites. Un cartographe divise parfois le paysage selon les différences de couleur et de texture sans connaître les unités ainsi délimitées. A moins qu'il ne découvre la signification de ces unités, sa carte n'aura que peu de valeur. Les cartes les plus utiles sont celles qui utilisent de façon logique et uniforme des critères précis, déterminés au cours de l'échantillonnage et de l'établissement des cartes sur place. Elles sont à la fois lisibles et explicatives et sont susceptibles de faire l'objet d'un examen critique et d'être améliorées.

* *Le Système de la Classification des Sols du Canada.* 1978. Commission canadienne de Pédologie. Agriculture Canada. N° Publ. 1646. 164p.

Nous avons déjà dit que les unités écologiques importantes sont visualisées et reconnues comme exprimant les processus génétiques (évolutifs) et fonctionnels. A partir de "cartes mentales" des caractéristiques importantes, le taxonomiste trouve les unités génétiques et fonctionnelles au moyen d'un stéréoscope, sur les cartes et sur place. Ces dernières peuvent ensuite être décrites par leurs propriétés inhérentes et catégorisées, ce qui en fait des unités significatives. Le problème des critères de délimitation se ramène donc aux *indicateurs* et aux *générateurs* de processus et de fonction le paysage.

En ce qui concerne les indicateurs, les éco-systèmes paysagers se composent d'une couche atmosphérique et d'une couche terrestre ou aquatique, les organismes se trouvant à l'interface où se concentre l'énergie. Toutes les composantes sont également importantes et indispensables au développement des écosystèmes. Il est parfois soutenu que la composante (biote, sol, relief, eau) choisie pour déterminer les types d'unités écologiques d'une région donnée et les limites de chaque type, est une question de goût personnel. L'inconvénient de ce type de sélection est qu'il entraîne de nombreuses classifications différentes d'utilité inégale, toutes fines et thématiques en apparence sinon en réalité, qu'il nous éloigne de l'objectif de l'interciplinarité en classification écologique.

La solution serait peut-être de rechercher les indicateurs (visibles en surface et sur des photos aériennes) pouvant être identifiés avec les générateurs de phénomènes fonctionnels et de processus dans différentes parcelles de terrain. De cette façon, on découvre que le climat constitue le principal élément déterminant des écosystèmes, indiqué à différentes échelles (de régionales à locales) par des modèles de végétation, de relief et de drainage facilement observables. La façon dont ces modèles sont utilisés, ainsi que l'importance des composantes, dépendra en partie du type de terrain et de l'échelle.

Les taxonomistes, conviennent que dans un système hiérarchique, les critères discriminants aux échelons supérieurs (c'est à dire ceux qui servent à établir les unités régionales) doivent être plutôt généraux en importance et avoir le plus grand pouvoir totalisateur, tandis que ceux des échelons inférieurs (c'est à dire ceux qui servent à établir des unités locales) doivent être plus spécifiques en importance. Par 'importance' nous entendons pertinence quant aux corrélation avec d'autre propriétés significatives. Il existe donc plusieurs lignes directrices de sélection des critères de relation les plus utiles pour reconnaître et pour délimiter les

unités de classification écologique à tous les niveaux.

UN EXEMPLE

La classification par groupement ne permet pas de découvrir des unités écologiques importantes. Ces dernières doivent être perçues comme des touts ayant une certaine importance morphogénétique ou écofonctionnelle. Par exemple, prenons quatre unités décrites par ordre décroissant:

(1) Écorégion (Région écologique) - Unité macroclimatique où tous les processus écologiques se retrouvent actuellement dans un grand régime. Elle est délimitée par des macro-indicateurs du sol et de la biote, associés aux changements climatiques en latitude et en longitude.

(2) Écodistrict (District écologique) - Unité sous-régionale où, en raison de l'altitude (relief) et du substrat géologique, le régime climatique diffère nettement de celui des terres adjacentes. Par exemple, le district écologique d'un plateau élevé peut représenter un massif détaché d'une région écologique plus nordique. Cette unité est délimitée par des changements macroscopiques du relief et de la roche en place.

(3) Écosection (Système écologique) - Unité intermédiaire dont la forme exprime un processus climatique et géomorphologique (fluvial, colluvial, éolien, glaciaire, etc.). Par exemple, un relief morainique en bosses et creux, des matériaux transportés grossiers et stratifiés, etc. Elle est délimités par des mésochangements des formations superficielles et du relief.

(4) Écosite (Type écologique) - Petite unité topographique, un des éléments caténaires du système écologique, avec uniformité dans le drainage du sol, la végétation et le climat local, lesquels sont reliés fonctionnellement.

L'exemple précédent qui souligne l'importance de la biote, du sol, du relief, etc. à différents niveaux appelle une mise en garde. Même si certains indicateurs biotiques et certaines caractéristiques physiographiques peuvent se révélés particulièrement utiles à divers niveaux de la classification écologique, ils peuvent l'être également à d'autres niveaux lorsqu'ils sont convenablement généralisés. Par exemple, la physionomie de la végétation qui reflète le climat régional (niveau 1) est très différent de la composition et de l'abondance des espèces qui caractérisent le climat local (niveau 4). Même si le relief est important pour délimiter les districts (niveau 2), il permet également de définir les systèmes écologiques (niveau 3), car c'est l'une des caractéristiques importantes des formes du terrain. L'importance de la geologie varie d'un niveau à l'autre; elle sert surtout à définir de vastes régions (niveaux 1 et 2) et à fournir des indices sur la distribution des matériaux originels du sol (niveaux 3 et 4).

Même s'il est possible de cartographier les niveaux d'après les caractéristiques physiographiques et biologiques, il faut toujours faire une vérification afin de s'assurer que les unités ont une importance écologique. Une carte climatique indiquant des facteurs clés tels que la température et les précipitations n'est pas une carte écologique *tant que* les unités ne correspondent pas à des unités biologiques importantes. Une carte géomorphologique qui représente des caractéristiques telles que les matériaux superficiels et le relief, n'est pas une carte écologique *tant qu'*il n'y a pas une certaine correspondance entre les formes du terrain et les sols et la végétation. Les cartes écologiques *tant qu'*il n'est prouvé que les types correspondent aux caractéristiques physiographiques et qu'il ne s'agit pas simplement d'accidents et de vestiges d'environnements différents antérieurs.

Rien ne laisse entendre que les quatre niveaux de classification des terres sont nécessaires tout temps; il pourrait y avoir deux ou douze niveaux pourvu que les objectifs visés soient atteints. Toutefois, il est préférable que le système de base ne comporte qu'un petit nombre d'unités (quel que soit leur appellation) sur lesquelles tous les spécialistes de la classification pourraient se baser et entre lesquelles d'autres éléments pourraient s'insérer au besoin.

SOMMAIRE

Même s'il existe une certaine communauté d'idées à l'heure actuelle, il n'y a pas de démarche unique pour la classification du territoire. Pour trouver une base commune, il faut connaître chaque système de façon à définir les concepts et à délimiter les parcelles de terrain en fonction d'éléments et de critères précis. Certains spécialistes importants de la classification du territoire ont déjà systématisé leurs travaux et ce rapport ne vise pas à les critiquer. Toutefois, l'essor donné récemment à la classification écologique du territoire au Canada a entraîné l'arrivée de nombreuses nouvelles équipes de travail; il est donc temps de faire une étude critique des principes et de faire un effort dans tout le pays en vue d'obtenir une meilleure compréhension de cette tâche d'envergure.

Les commentaires de toutes les personnes intéressées sont bienvenus. Les analyses critiques du présent rapport et les suggestions constructives sur la façon de préciser les notions et les méthodes seront également appréciées. Bien que ce rapport soit le résultat d'un travail collectif, il ne donne cependant pas un avis commun à tous les collaborateurs. Nous espérons toutefois que c'est une étape vers cet objectif.

REMERCIEMENTS

Nous tenons à remercier les nombreuses personnes qui ont commenté le rapport provisoire distribué en 1977. Même si elles n'ont pas sanctionné entièrement cette version, leurs noms figurent dans la liste suivante:

Australie: R.H. Gunn, J.G. Speight, R. Story
Angleterre: R.G.H. Bunce, M. F. Thomas
États-Unis: R.J. Alvis, R.G. Bailey
J.M. Crowley, C. Hutchison
R.D. Pfister, C.J. Robinove
Canada: R.E. Bailey, A. Boissonneau
R.W. van Barneveld, W.A. Celentino
Canada: A. Crowder, D. Day, P.J.B. Duffy,
W.A. Fuller, R.F. Fulton,
I. Gillies, F.B. Goldsmith,
D.L. Handley, J. Jeglum
M. Jurdant, A. Kosowan,
P. Kumar, J.D.H. Lambert,
A. Moss, J.G. Nelson,
J.J. Nowicki, P. Ojamaa
W.W. Pettapiece, R. Revel,
R.A. Ryerson, A. Schori
R. Starling, W.R. Stephenson,
P.E.K. Symons, J. Thie,
D. Welch, E. Wiken.

ECOLOGICALLY BASED PLANNING: A REPORT ON THE CCELC URBAN WORKSHOP

E. B. Wiken
Lands Directorate
Environment Canada
Ottawa, Ontario

ABSTRACT

In compliance with a recommendation which was made at the first meeting of the CCELC, a workshop on ecological land classification in urban areas was convened. This workshop was sponsored by the secretariat of the Committee; support was also given by the Central Mortgage and Housing Corporation.

Approximately 60 individuals from Canadian governmental agencies, consulting firms and universities attended. The major theme of the workshop was to explore the role of an ecological information base in the urban planning process. As such, the papers and working group sessions covered aspects of climatology, geology, soils, hydrogeology, forestry, wildlife, flood risk, ecological land surveys, policy planning and environmental programs in urban areas.

RÉSUMÉ

Conformément à une recommandation formulée lors de la première réunion du CCCET, un atelier sur la classification du territoire urbain a été organisé. Il était parrainé par le secrétariat du Comité et a bénéficié de l'aide de la Société centrale d'hypothèques et de logement.

Y ont assisté environ 60 représentants d'organismes gouvernementaux canadiens, de firmes d'experts-conseils et d'universités. L'atelier avait pour principal thème l'étude du rôle d'une base d'information écologique dans la planification urbaine. Les sujets traités lors des réunions et dans les documents produits portaient sur la climatologie, la géologie, les sols, l'hydrogéologie, la foresterie, la faune, les risques d'inondation, les relevés écologiques du territoire, l'élaboration des politiques et les programmes environnementaux en milieu urbain.

INTRODUCTION

Ecological land surveys have been traditionally directed at rural and noncultural areas of Canada. These surveys were largely reconnaissance level programs and were primarily performed to collect information that would allow the assessment and development of natural and resources from a regional or less detailed planning perspective. Related types of surveys in urban areas have been, in comparison, more recent but they have advanced beyond the experimental stage. In addition, urban surveys are concerned with greater detail and with land ecosystems that are substantially man-modified rather than natural. As a result of these modifications man has become a dominant ecological force in the urban setting. However, human settlements are still open ecosystems dependent on an ecological balance for their continuous and harmonious existence. Communities rely on components of man-adapted ecosystems for the production of food stuffs and wood products, and for the supply of raw materials such as water, air, soil and certain minerals. If the consumption and use of these goods are improperly handled, then the basic requirements which sustain human settlements such as shelter, food, safety and health become threatened.

ECOLOGICALLY BASED PLANNING

Ecologically based planning, which emphasizes the application of ecological principles and information in planning activities, is one mechanism to harmonize and make compatible the interrelationships between urban development and those characteristics of land of critical importance for human use and well being. This form of planning is not considered a panacea and must, as well, be complemented by a social, economic and political information base. However, the Toronto Workshop (CCELC, 1977b) was convened to explore and amplify what ecologically based planning should comprise. This was in compliance with a recommendation

made at the first meeting of the Committee (CCELC, 1977a). Based on the papers and discussions of approximately 60 specialists from governmental and nongovernmental agencies, the salient aspects have been extracted and summarized in Figure 1. As noted in the upper portion of the diagram, two general steps are involved: the preparation of an ecological information base; and the application of this base in relation to current or proposed land uses.

Preparation of an Information Base

Owing to the increasing public awareness of environmental issues, the information needs of planners are fairly extensive. To properly plan urban development and to avoid adverse environmental impacts, a broad platform of information seems most appropriate. Major ecological components of the land such as climate, water, biota and terrain and their interactions have significance in assuring either that the environment of a settlement is not degraded to less desirable forms or that life and property are not endangered.

From the workshop study group sessions, it was concluded that while there was some information available for urban areas it was largely insufficient and not always readily usable. This inadequacy of information undoubtedly hampers the urban planning urban process. Following the workshop, the existing information for the 52 largest urban centres was tabulated. Table 1 presents the results as correlated to two mapping scales: the 1:50,000, and the 1:25,000. Larger mapping scales were not included as the available information is negligible; smaller scales were ommitted as they are of less of value for urban planning needs. Considering that nearly 65% of Canada's population is associated with these 52 settlements, it is surprising that such a dearth of information exists (Table 1). For the 1:50,000 mapping scale in both the Census Metropolitan Areas and the selected Census Agglomerations (centres with populations greater than 25,000), less than 50% of these urban areas have geological or soils information. In addition, information related to vegetation, hydrology, wildlife and climate is essentially absent. For the 1:25,000 mapping scale, the available information is significantly less extensive.

Since basic information is only partially complete or is totally absent in most urban areas, participants of the workshop felt that an ecological information base should be gathered. The appropriate method of gathering information is reflected in the basic data requirements put forward in the papers. Although different disciplines have their own peculiar interests, the basic data required by each often emanates from a rather limited number of common sources. For example, the data secured about vegetation can be used by the pedologist, the wildlife biologist and the climatologist in determining the interrelationships and nature of his subject of interest. By acknowledging these mutual requirements and coupling this with the broad platform of information demanded in land use planning decisions, an integrated approach to land survey appears to be practical. This point was drawn in the study group sessions. An integrated approach would have numerous advantages over interpretative surveys or a comparable number of single-disciplinary studies: (1) basic descriptive data can be interpreted for a wide variety of applications; (2) the time and money spent on data collection would be minimized as overlap and duplication in transportation, fieldwork, support staff and material production is reduced; (3) the proliferation of non-concordant boundaries of natural phenomena would be avoided; (4) the emphasis on stable characteristics of the land would maintain the survey's usefulness in the long term; and (5) the information on characteristics of the land is assembled in one convenient package.

Application of a Data Base

Once a data base has been collected, the land characteristics identified can assist in indicating which uses are compatible and which components need adjustment before a use is instituted. Recognizing this relationship has bearing on whether or not the basic requirements of man in a human settlement are achieved without great private or public expense. In the modern community human activities are varied, including transportation, housing, recreation, waste disposal, servicing, commerce and property disposition. Each activity is, to some degree, affected by the characteristics of the land or, in turn, has some effect on the land itself. When these interrelationships between man and land are adverse, the impact may be conspicuous such as in the loss of life or property, or less conspicuous such as in the cracking of foundations, flooding of basements, the pollution of potable groundwater sources, etc. Correcting the causative agents of these problems after land has been committed to an urban use is frequently awkward and costly. The problems may, indeed, continue as a committed parcel of land often acts to seed similar land uses in the surrounding vicinity.

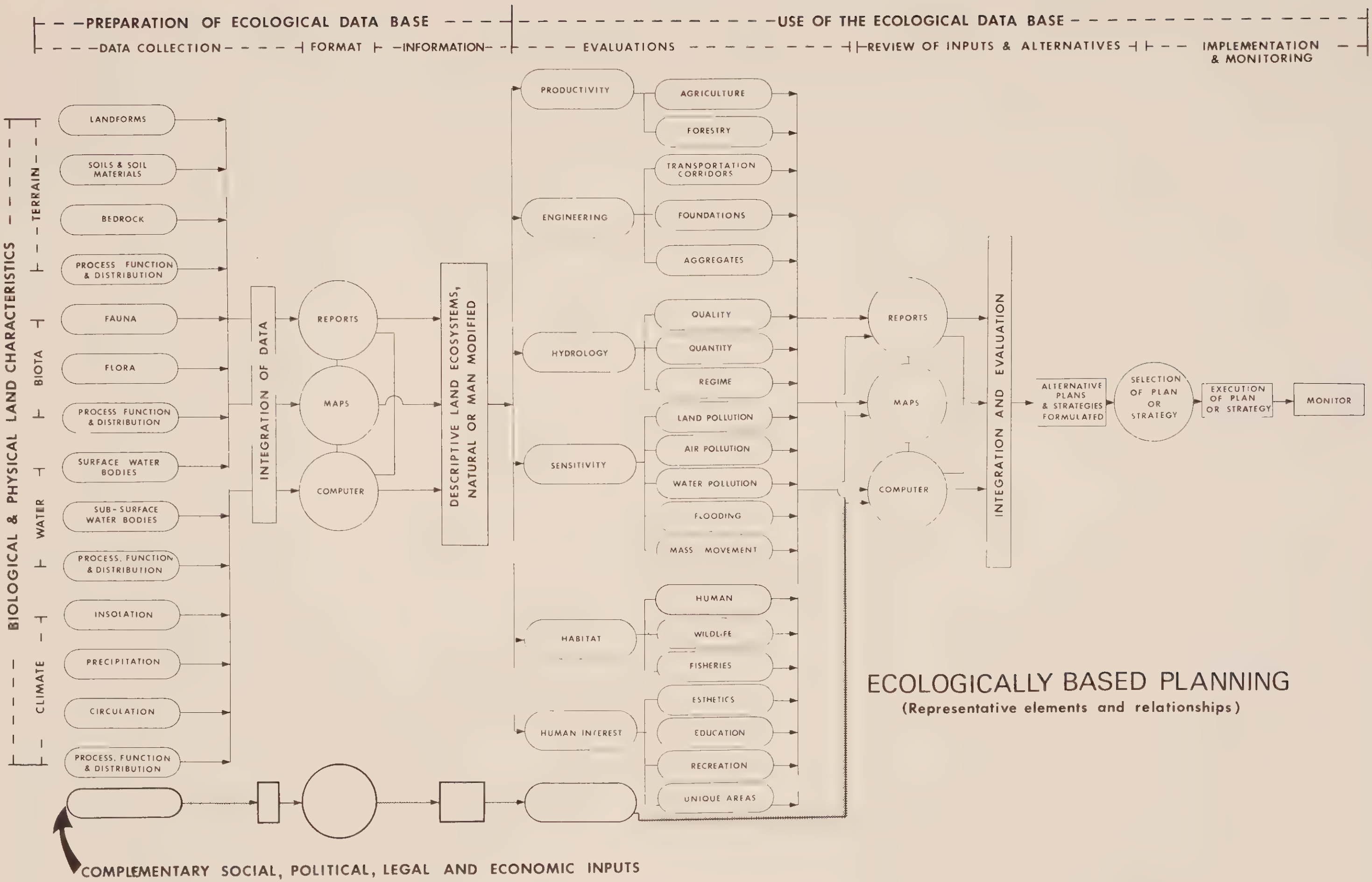


Figure 1: Ecologically based planning, representative elements and relationships.

	Percent of Urban Areas With Information			
	*CMA's		** CA's	
INFORMATION	1:50,000	1:25,000	1:50,000	1:25,000
Fauna	Nil	Nil	Nil	Nil
Flora	Nil	Nil	Nil	Nil
Surficial Geology	36	Nil	7	Nil
Bedrock	18	5	17	17
Seismic Risk	Nil	Nil	Nil	Nil
Geotechnical Data	86	Nil	3	Nil
Topography	100	82	100	23
Soil Survey	45	23	58	7
Soil Engineering	5	23	Nil	Nil
Landforms	5	7	Nil	Nil
Adverse Soils	55	46	Nil	Nil
Groundwater	Nil	Nil	Nil	Nil
Flood Risk	Nil	Nil	Nil	Nil
Climate	Nil	Nil	Nil	Nil

* Census Metropolitan Areas - urban centres having a population greater than 100,000

** Census Agglomerations - only CA's or urban centre having a population greater than 25,000 were considered.

Table 1: Summary of the ecological information bases for selected urban areas and mapping areas.

If ecological data are evaluated beforehand in reference to particular land uses, many of the more adverse environmental impacts could be circumvented. The generated interpretations would establish the inherent degree of compatibility or incompatibility with the various forms of land ecosystems. Several examples are provided in the papers contained within the proceedings of the workshop. For instance, sites with soil and bedrock having suitable mechanical properties to support structures could be designated; areas subject to extreme wetness or inundation could be demarcated to avoid water damage to residential or commercial structures; atmospheric conditions could be characterized to avoid air and noise pollution; and the water cycle could be described such that water pollution is not encouraged and recharge zones for groundwater are protected.

Intepretations provide the foundation for environmental impact and assessment analysis. This information constitutes one dimension which should be incorporated in the derivation of plans for urban areas. As with other imputs such as social, economic and political information, an ecological information base is an important determinant in the planning process. Its inclusion will undoubtedly benefit the community at large.

This act of incorporating ecological information into the planning process was thought by workshop participants to be weak. Consequently, it was recommended that this link be strengthened. To this effect, the secreatriat of the Committee has encouraged contractual support for a *Resourcebook on Environmental Planning* (Lang, 1978).

CONCLUSIONS

Because of population concentration, human settlements are marked by some of the more dramatic changes in land ecosystems, including natural or man adapted forms. Such events can have profound ramifications in meeting fundamental human needs. If the effects of urbanization on ecosystems are not well understood, then man's security and integration with the ecological cycle remains infirm. Unsatisfactory settlements may evolve and be manifested by noise, air and water pollution, slums, misuse of natural resources, food and energy shortage and increased social and economic costs.

REFERENCES

Canada Committee on Ecological Land Classification. 1977a. Ecological (Biophysical) Land Classification in Canada: Proceedings of the First Meeting (ed by J. Thie and G. Ironside) ELC Series No. 1, Lands Directorate, Ottawa, 269 p.

Canada Committee on Ecological Land Classification. 1977b. Ecological (Biophysical) Land Classification in Urban Areas: Proceedings of a Workshop (comp. and ed. by E.B. Wiken and G.R. Ironside). ELC Series No. 3, Lands Directorate, Ottawa. 167 p.

Lang, R. et al. 1978. Resourcebook on Environmental Planning. Draft Report. Faculty of Environmental Studies, York University.

PLANIFICATION ÉCOLOGIQUE: UN RAPPORT D'UN ATELIER URBAIN DU CCCET

E. B. Wiken
Direction générale des terres
Environnement Canada
Ottawa, Ontario

RÉSUMÉ

Conformément à une recommandation formulée lors de la première réunion du CCCET, un atelier sur la classification du territoire urbain a été organisé. Il était parrainé par le secrétariat du Comité et a bénéficié de l'aide de la Société centrale d'hypothèques et de logement.

Y ont assisté environ 60 représentants d'organismes gouvernementaux canadiens, de firmes d'experts-conseils et d'universités. L'atelier avait pour principal thème l'étude du rôle d'une base d'information écologique dans la planification urbaine. Les sujets traités lors des réunions et dand les documents produits portaient sur la climatologie, la géologie, les sols, l'hydrogéologie, la foresterie, la faune, les risques d'inondation, les relevés écologiques du territoire, l'élaboration des politiques et les programmes environnementaux en milieu urbain.

ABSTRACT

In compliance with a recommendation which was made at the first meeting of the CCELC, a workshop on ecological land classification in urban areas was convened. This workshop was sponsored by the secretariat of the Committee; support was also given by the Central Mortgage and Housing Forporation.

Approximately 60 individuals from Canadian governmental agencies, consulting firms and universities attended. The major theme of the workshop was to explore the role of an ecological information base in the urban planning process. As such, the papers and working group sessions covered aspects of climatology, geology, soils, hydrogeology, forestry, wildlife, flood risk, ecological land surveys, policy planning and environmental programs in urban areas.

INTRODUCTION

Au Canada, les relevés écologiques des terres portaient jusqu'ici sur des régions rurales ou non cultivées. Ces relevés étaient en bonne partie effectués à des fins de reconnaissance et servaient avant tout à recueillir des données permettant d'évaluer et de mettre en valeur les richesses naturelles dans une perspective de planification régionale ou plus vaste. En comparaison, les relevés similaires en régions urbaines sont plus récents, bien qu'ils aient dépassé le stade expérimental. Par ailleurs, ils se caractérisent par un plus grand souci du détail et traitent d'écosystèmes modifiés de façon importante par l'homme et qui ne sont donc pas naturels. En raison de ces modifications, l'homme est devenu la principale force écologique en milieu urbain.

Le maintien et l'harmonie des établissements humains n'en reposent pas moins sur un équilibre écologique puisque ces é-ablissements continuent d'être des écosystèmes ouverts. Dans ces communautés, ce sont des éléments d'écosystèmes modifiés par l'homme qui assurent la production des aliments et des produits du bois ainsi que l'approvisionnement en matières premières, en particulier en eau, en air, en sol et en certains minéraux. Toute erreur dans la consommation et l'utilisation de ces biens menacent les besoins fondamentaux des établissements humains, qui sont l'abri, l'alimentation, la sécurité et la santé.

LA PLANIFICATION ÉCOLOGIQUE

Une planification qui s'appuie sur les principes et les données écologiques, est l'un des moyens d'adapter de façon harmonieuse le développement urbain aux caractéristiques des terres dont l'importance est vitale pour les besoins et le bien-être des hommes. Ce type de planification, qui n'est pas considéré comme une panacée, doit, par ailleurs, s'inspirer d'une base de données sociales, économiques et politiques. L'atelier de Toronto (CCCET, 1977b) a été convoqué pour étudier et mettre en lumière le contenu idéal d'une telle planification écologique. Cet objectif correspond à une recommandation faite lors de

la première réunion du Comité (CCCET, 1977a).Les points saillants des mémoires et des exposés d'environ 60 spécialistes d'organismes gouvernementaux et non gouvernementaux ont été relevés et sont présentés à la figure 1. Comme on peut le voir à la partie supérieure du diagramme, deux grandes étapes sont prévues: d'abord la constitution d'une base de données écologiques, puis l'application de celle-ci aux divers usages actuels et futurs des terres.

Constitution d'une base de données

Etant donné l'éveil croissant du public aux questions d'environnement, les planificateurs ont besoin d'un nombre considérable de données. Pour planifier judicieusement la croissance urbaine et pour éviter toute incidence néfaste sur l'environnement, il faut disposer de tout un éventail de données. Les principaux facteurs écologiques, à savoir le climat, l'eau, la biote et le terrain, ainsi que l'interaction de ces différents facteurs, contribuent sensiblement à prévenir la dégradation de l'environnement, ou les risques pour la vie et les biens.

A l'issue des séances de travail du groupe d'étude de l'atelier, on a conclu que les quelques données disponibles sur les régions urbaines étaient loins d'être suffisantes et n'étaient pas toujours immédiatement exploitables. Ce manque de données pertinentes nuit hors de doute au processus de planification urbaine. A la suite de l'atelier, les données disponibles relativement aux 52 agglomérations urbaines les plus importantes ont été mises en tableau. Le tableau 1 présente les résultats obtenus selon les deux échelles cartographiques suivantes: 1:25 000 et 1:25 000. Aucune échelle supérieure n'a été employée, les données disponibles à cet effet étant trop peu nombreuses; par ailleurs, on ne s'est pas préoccupé des échelles inférieures, celles-ci étant de moindre importance en planification urbaine. Si l'on considère que ces 52 établissements comptent près de 65% de la population canadienne, la pénurie actuelle de données (tableau 1) a de quoi étonner. En effet, moins de 50 pour cent des régions métropolitaines et des agglomérations (villes de plus de 25 000 habitants) de recensement portées à l'échelle 1:50 000 disposent de données géologiques ou de données sur leurs sols. De plus, elles ne disposent pratiquement d'aucune donnée en matière de végétation, d'hydrologie, de faune, et de climat. Et à l'échelle 1:25 000, les données existantes sont encore moins nombreuses.

Les données de base étant incomplètes ou tout simplement inexistantes pour la plupart des régions urbaines, les participants à l'atelier ont recommandé la création d'une base de données écologiques. Quant à la méthode appropriée pour la collecte des informations, elle est fonction des données de base qui ont été jugées indispensables dans les divers mémoires. Bien que chaque discipline ait des centres d'intérêt propres, les données de base qui lui sont nécessaires parviennent d'un nombre relativement restreint de données communes. C'est ainsi que les données recueillies au sujet de la végétation peuvent servir en pedologie et en biologie de la faune, aussi bien qu'en climatologie, à étudier l'objet propre à chacune de ces sciences ainsi que les interrelations qui les caractérisent. Compte tenu de ces besoins communs, d'une part, et de l'ensemble des données indispensables à la planification de l'utilisation des sols, il conviendrait de centraliser l'établissement des relevés des sols. Cette conclusion a été tirée aux différentes réunions du groupe d'étude. Une telle approche offrirait nombre d'avantages sur les relevés interprétatifs ou sur un nombre comparable d'études uni-disciplinaires, en particulier les suivants: (1) les données descriptives de base pourraient servir à tout un éventail d'applications; (2) l'investissement en temps et en argent nécessaires à la collecte des données pourrait être réduit au minimum, vu l'élimination des doubles emplois en matière de transport, de travail sur le terrain, de personnel de soutien et de production; (3) la prolifération de limites non concordants à des phénomènes naturels serait évitée; (4) la mise en relief des caractéristiques stables des sols assurerait l'utilité à long terme des relevés et (5) toutes les données relatives aux sols seraient réunies dans un ensemble unique et pratique.

Utilisations d'une base de données

Une fois réunie la base de données, les caractéristiques des terres qui y figurent peuvent contribuer à déterminer l'usage qui leur convient et les éléments qui doivent auparavant subir des modifications. Il importe de tenir compte de cette relation, pour répondre aux besoins fondamentaux d'un établissement humain sans engager des dépenses importantes d'ordre privé ou public. Les activités humaines d'une communauté moderne sont très diverses et vont du transport au logement, aux loisirs, à l'élimination des déchets, aux services, au commerce et à la cession de biens. Dans une certaine mesure, chacune de ces activités est influencée par les caractéristiques des terres où elles ont lieu, tout comme, en retour, elles ont une incidence sur elles. Le manque d'harmonie

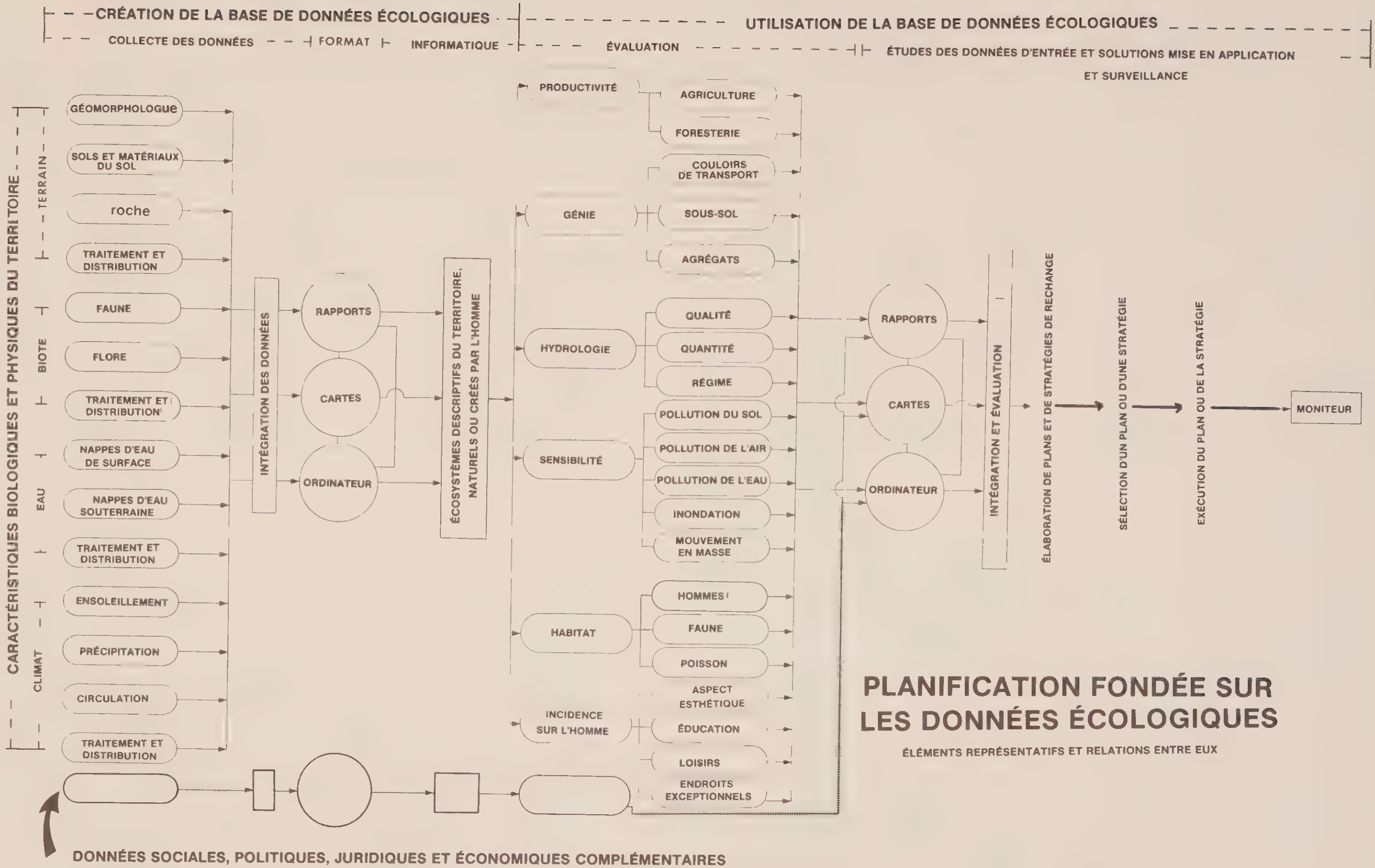


Figure 1: Planification fondée sur les données écologiques - éléments représentatifs et relations entre eux.

DONNEES	*R.M.R. 1:50 000	*R.M.R. 1:25 000	** A.R. 1:50 000	** A.R. 1: 25 000
Pourcentage de régions urbaines pour lesquelles des données sont disponibles				
Faune	Nil	Nil	Nil	Nil
Flore	Nil	Nil	Nil	Nil
Géologie superficielle	36	Nil	7	Nil
Roche de fond	28	5	17	17
Risque de séisme	Nil	Nil	Nil	Nil
Données géothechniques	86	Nil	3	Nil
Topographie	100	82	100	23
Relevé du sol	45	23	58	7
Génie des sols	5	23	NIl	Nil
Topographie	5	7	Nil	Nil
Sols impropres à la culture	55	46	Nil	Nil
Nappe phréatique	Nil	Nil	Nil	Nil
Risque d'inondation	Nil	Nil	Nil	Nil
Climat	Nil	Nil	Nil	Nil

* Régions métropolitaines de recensement, agglomérations urbaines de plus de 100 000 habitants

** Agglomérations de recensement, agglomérations urbaines de plus de 25 000 habitants seulement.

Tableau 1 - Sommaire des bases de donées écologiques pour les régions urbaines retenues et les régions ayant fait l'objet de relevés cartographiques.

entre l'homme et le sol peut avoir des résultats désastreux, par exemple, la perte de la vie ou de biens, ou des conséquences fâcheuses comme des lézardes dans les fondations, l'inondation de sous-sols, la pollution de sources d'eau souterraine potable, etc.. Il est souvent difficile et coûteux de supprimer la cause de ces problèmes une fois que des terres ont été déclarées zones urbaines. Ce genre de problèmes peut certes subsister, étant donné qu'une parcelle de terre communique souvent sa "vocation" aux parcelles qui l'entourent.

En évaluant les données écologiques concernant certaines terres avant d'affecter celles-ci, on peut éviter un grand nombre de conséquences fâcheuses pour l'environnement. Une telle évaluation établit d'elle-même un certain degré de compatibilité ou d'incompatibilité avec divers types d'écosystèmes des terres. Les exposés contenus dans les comptes rendus de l'atelier en fournissent plusieurs exemples. On peut ainsi désigner les emplacements dont le sol et la roche de fond possèdent les propriétés mécaniques susceptibles de supporter des structures; ces données permettent d'exclure les régions extrêmement humides ou inondées afin d'éviter l'endommagement par l'eau de bâtiments domiciliaires ou commerciaux; on peut préciser les conditions atmosphériques favorables pour éviter la pollution de l'air ou la pollution par le bruit; finalement, on peut déterminer le régime hydrographique propre à minimiser la pollution de l'eau et à protéger les zones d'enrichissement des nappes phréatiques.

L'interprétation des données sert de point de départ dans l'évaluation des terres et de l'incidence de leur affectation sur l'environnement. C'est l'un des outils de l'élaboration des plans pour les régions urbaines. Parallèlement aux autres données, de nature sociale, économique et politique, la base de données écologiques est un élément détermimant dans le processus de planification. Cet apport bénéficiera sans aucun doute à l'ensemble de la communauté.

Cette intégration des données écologiques dans le processus de planification a semblé trop timide aux participants de l'atelier. C'est pourquoi ceux-ci ont recommandé de renforcer cette intégration. A cette fin, le Secrétariat du Comité a recommandé que l'on appuie par contrat la rédaction du rapport intitulé *Resourcebook on Environmental*

Planning (Lang et al, 1978).

CONCLUSIONS

Etant donné la concentration de la population, les établissements humains sont le théâtre de modifications profondes des écosystèmes de terres vers des formes naturelles ou créées par l'homme. Cette évolution peut avoir d'importantes conséquences sur la possibilité de répondre aux besoins humains fondamentaux. Si l'incidence de l'urbanisation sur les écosystèmes n'est pas bien comprise, la sécurité et l'intégration de l'homme au cycle écologique restent imparfaites. Des établissements déficients peuvent se déveloper et se manifester dans le bruit, l'air et l'eau, les taudis, et une mauvaise utilisation des richesses naturelles, le manque de nourriture et d'énergie ainsi que des coûts sociaux et économiques accrus.

BIBLIOGRAPHIE

Comité canadien de classification écologique du territoire. 1977a. Classification écologique (biophysique) du territoire du Canada - Compte rendu de la première réunion. (édité par J. Thie et G. Ironside). Série de la Classification écologique du territoire, N° 1. Direction générale des terres, Environnement Canada, Ottawa. 269 p.

Comité canadien de classification écologique du territoire. 1977b. Classification écologique (biophysique) du territoire dans les région urbaines - Compte rendu d'un atelier, (comp. et éd. par E.B. Wiken et G.R. Ironside). Série de la classification écologique du territoire, N° 3. Direction générale des terres, Environnement Canada, Ottawa. 167 p.

Lang, R. et al. 1978. Resourcebook on Environmental Planning. Draft Report. Faculté des études d'environnement, Université York.

ECOLOGICAL CLASSIFICATION OF FOREST LAND IN CANADA AND NORTHWESTERN U.S.A.: REPORT ON THE 1977 VANCOUVER SYMPOSIUM *

J. P. Kimmins
Faculty of Forestry
The University of British Columbia
Vancouver, British Columbia

ABSTRACT

This paper reviews presentations made at a recent Vancouver symposium on ecological classification of forest land.

The symposium served as a statement of the present status quo of ecological land classification in Canada and the Pacific Northwestern States and illuminated the variety of approaches that can be used. The symposium did not settle any issues nor did it confront the question of which of the various approaches is best. Rather, it served to generate interest in the topic, to expose the variety of methods that have been found to be useful under various conditions, and hopefully, to stimulate further debate and evaluation of the alternative approaches.

RÉSUMÉ

Ce document examine les exposés faits lors d'un récent symposium tenu à Vancouver sur la classification écologique des terres forestières.

Le symposium a servi à faire état du status quo actuel de la classification écologique des terres au Canada et dans le nord-ouest des États-Unis et a fait ressortir la diversité des méthodes pouvant être utilisées. Lors de ce symposium, on n'a établi aucune question litigieuse, ni cherché à savoir quelle méthode est la meilleure. On s'est plutôt intéressé, au contraire, à répandre l'intérêt sur le sujet, à exposer les différentes méthodes jugées utiles dans diverses conditions, et espère-t-on, à stimuler la discussion et l'évaluation des méthodes possibles. (Trad. Éd.)

INTRODUCTION

Ecological classification of forested land has undergone a renaissance in British Columbia over the past five years. The small wave of activity that was initiated in the 1940s by Spilsbury and Smith grew steadily over the subsequent decades under the tutelage of Dr. Vladimir Krajina of UBC, and finally broke on the shores of B.C. forestry about three years ago. The recent adoption for evaluation, testing and implementation of Krajina's biogeoclimatic classification approach by the B.C. Forest Service Research Division constitutes a major event in the evolution of ecological land classification in the province. Other similar classification activities in B.C. predate the recent interest of the Forest Service in ecological classification, the achievements of British Columbia Forest Products, MacMillan and Bloedel, and Pacific Logging being most noteworthy. All three of these forest companies actively engaged in ecological classification of forest lands under their management in the early 1970s.

Ecological classification activities in B.C. at the Universities, by forest industry and by the B.C. Forest Service have a parallel in analogous environmental inventory and/or classification work by Canada Land Inventory, by the Canadian Forestry Service and, more recently, by the Resource Analysis Branch of the Provincial Government. It is still a matter for debate as to whether some of these parallel activities constitute inventories rather than true classifications, and some of them have focused on either single or limited sets of environmental parameters which obviates calling them ecological classifications in the fullest sense of this term. However, the recent trends in biophysical classification have rendered that approach increasingly ecological, as reflected in the name of the Canada Committee (CCELC). The difference between inventory and hierarchial classification remains.

The dramatic increase in ecological classification activity in B.C. in the 1972-76 period was marked by the development of three major schools of classification. It seems to be a hallmark of this discipline to have a variety of *schools* or *traditions*. Consider, for example, the wide diversity of approaches to vegetation

* This Symposium was sponsored and organized by the Canadian Insitute of Forestry.

classification that developed in Europe and Scandinavia over the past century, accompanied by decades of argument and debate about which was the *best* approach. More recently, it has been increasingly realized that in many cases the different approaches serve different objectives and that they have evolved in response to differing ecological conditions. In some cases it may be desirable to utilize two or more compatible approaches to achieve the *best* classification. In others, one approach may clearly be superior to the others.

Hopefully, we in B.C. can learn from this lesson by active and open consideration of the objectives of the three different *schools* and by detailed comparison and evaluation of their relative merits and of the conditions under which each may make its greatest contribution. Such comparisons are essential in today's economic climate in which unnecessary duplication of effort cannot be tolerated. If such comparisons and evaluations reveal that either two, or all three, of the present approaches have the same or closely similar objectives and applications, and if all three are supported by public funds, it may be necessary to make some hard choices to limit activity to one major approach in the interests of economy and uniformity. Should one of the approaches emerge as clearly the *best* (relative to the objectives of the user), the choice may be easy; otherwise, it will be difficult but nevertheless it may have to be made. If, on the other hand, we find that the different approaches serve different purposes, or that they have different relative merits in different types of environment, the current diversity of approaches should probably be retained. Alternatively, critical evaluation may reveal that the different approaches are complementary and compatible and that a hybrid system is the most appropriate.

The old adage that *the proof of the pudding is in the eating* applies in this case: time and practical experience will ultimately show which is the best overall approach to ecological classification of forest land in B.C. However, until such experience has been gained, a continuing debate of the three approaches is appropriate. We should actively engage in critical comparisons since we cannot afford to rely solely on empirical experience which requires many decades before sufficient experience has been accumulated.

The lack of access by the general forestry sector in B.C. to the growing debate over the relative merits of the different classification approaches, and the lack of a general statement as to the extent of such classification in B.C., other parts of Canada and the Pacific Northwestern U.S. evoked the idea of a symposium. This was held in late September 1977 in Vancouver, B.C. attended by some 200 registrants. The objective of the symposium was to make a statement as to the *status quo* in ecological classification of forest lands in B.C., in Canada, and in the Pacific Northwest of the USA. It was intended to identify the various approaches that can be and are being used by different agencies. A decision was made to avoid any confrontation debates between competing philosophies or any highly technical discussions of the relative merits of the three major approaches: rather, it was a chance to display the variety of alternatives that are available and are being employed. The critical evaluation of the different approaches is yet to come.

In the following pages, I will outline the nature of the papers presented at the Symposium. The full proceedings can be obtained from the Centre for Continuing Education, UBC, Vancouver (Attn: Mr. Graham Drew). It is hoped to publish a streamlined version of most of the papers in a future edition of the Forestry Chronicle.

ECOLOGICAL LAND CLASSIFICATION IN BRITISH COLUMBIA

After a brief statement on the need for ecological classification in forestry, by the present author, Dr. Vladimir J. Krajina (Honorary Professor of Botany, UBC) gave the keynote address on the overall structure of his biogeoclimatic classification of British Columbia. The province is divided into a number of broad classes on the basis of climatic parameters. The most important of these subdivisions is the biogeoclimatic zone which is defined by characteristics of the climate, soils and climax vegetation. Subdivision of the zones into subzones reduces the heterogeneity of the vegetation: subzones are characterized by particular patterns of plant communities (and their successional development) on given types of soil and topographic features. Subzones are divided up into biogeocoenoses: the smallest unit used regularly in the classification. Dr. Krajina went on to describe two further developments of this approach which are employed to facilitate the use of classification in practical land management. Firstly, the edaphic grid was described. This is a two-dimensional diagrammatic summary of the biogeocoenoses and the potential productivity of individual tree species within a subzone. The two parameters defining the axes of the grid are the moisture status (hygrotope) and the nutrient status (trophotope) of the site. These grids have recently become the basis for the highly successful tree species selection and prescribed burning guides presently being developed and used by the B.C. Forest Service. The second

development is the definition of management units. Biogeocoenoses that respond similarly to harvesting and site treatment are grouped together into a management (i.e. treatment) unit. This results in management maps that are far simpler and easier to interpret than maps at the level of biogeocoenose.

Following Dr. Krajina, three speakers (Mr. Ralph Schmidt, Dr. Karel Klinka and Dr. Richard Annas of the Research Division, B.C. Forest Service) described in more detail the general activities of the B.C. Forest Service in the field of ecological classification. Mr. Schmidt described the circumstances that have led to the adoption of ecological classification as the basis for future intensive forest management, the overall objectives of the program and the progress that is being made. Dr. Klinka described the use of edaphic grids and management units in the tree species selection and prescribed burning guides. Increasing concern over poor regeneration success and adverse consequences of slashburning led to the development of ecologically-based guidelines to assist the field manager in making improved decisions (hopefully the correct ones) concerning the use of fire in site preparation, and which species to plant on the variety of sites encountered in any subzone. Dr. Annas then described two examples of the current B.C. Forest Service classification and mapping work. The Forest Service has elected to map subzones at a scale of 1:500,000 in combination with training of field personnel to identify the major biogeocoenoses and management units found in the subzones under their management. It is felt that this is a better approach than the alternative of attempting to map the entire province at 1:20,000; such maps would show individual management units and the larger biogeocoenoses.

The focus of the presentations then switched to the recent activities of the Canadian Forestry Service in B.C. These can be classified into three major programs. The first involves the classification of the Yukon Territory. The first phase, now completed, involved the classification of the entire area into *ecoregions* (analagous to biogeoclimatic zones). The second phase involves a breakdown of ecoregions into *ecoareas* (analagous to subzones) which are to be mapped at a scale of 1:250,000. This project is expected to be completed in about 8 years. The third phase, which is already underway, involves more detailed mapping of an area of potential conflict between alternative resource users. It will result in maps of vegetation-terrain-soil-water units at a scale of 1:50,000. Dr. John Senyk described the philosophy and methodology employed and then went on to describe the other two activities: regional landscape analysis and involvement in B.C. Government agencies' land classification activities.

Much credit must be given to the few forest companies which have pioneered the industrial application of ecological land classification in B.C. Mr. Jack Toovey (Chief Forester, B.C. Forest Products) described the conditions that have stimulated the interest of forest companies in ecological classification and then went on to describe the programs of three companies: Pacific Logging, MacMillan and Bloedel and B.C. Forest Products (BCFP). It is interesting that these companies represent (more or less) the three major schools of classification in the province. Pacific Logging has used a combined biogeoclimatic-biophysical approach. MacMillan and Bloedel has used a combination of the biogeoclimatic approach (modified) and the U.S. forest habitat type approach. BCFP have utilized a slightly modified biogeoclimatic classification approach. Mr. Toovey concluded with an admonition to the developers of ecological classifications to work together, to always remember the user, and to avoid the proliferation of alternative approaches and terminologies.

A major component of ecological land classification in B.C. is being undertaken by the Resource Analysis Branch (RAB), B.C. Ministry of the Environment using the biophysical classification approach. This agency is responsible for the collection of data and the preparation of maps of the renewable resources of B.C. The objectives are thus broader than those of the B.C. Forest Service, but since forests constitute the major renewable resource in the Province, there is an element of duplication of effort. This apparent duplication was one factor in the genesis of the symposium and it will doubtless form the topic of continued debate and evaluation. The philosophy and methodology of the biophysical approach differs significantly from that of the biogeoclimatic approach, and the two systems result in somewhat different outputs. The task will be to identify the similarities and differences between the two approaches, to identify the ecological and social conditions under which each system is most effective, and to coordinate and meld the best from each approach in proportions that are relevant to each particular region of B.C. Mr. Walmsley of the RAB presented a detailed description of the biophysical approach to terrain and vegetation classification. His paper provides an excellent introduction to this approach and a comprehensive summary of its current application in B.C. This paper concluded the review of ecological classification activities in B.C.

ALTERNATIVE APPROACHES TO ECOLOGICAL CLASSIFICATION

The focus of the symposium switched at this point to a consideration of the various different methods of ecological land classification that have been developed. Professor Miroslav Grandtner (Université Laval) described the history of floristic classification in Canada: a method that is based upon the species composition of the vegetation. The advantages and disadvantages of this approach were discussed and it was pointed out that it can be an extremely valuable tool in predicting the quality and productivity of a site. The paper concluded with a description of the application of this approach in forest management.

Dr. Dys Burger (Ontario Ministry of Natural Resources) described the physiographic system of land classification as it has developed in Ontario. His paper provides a good summary of this method and its advantages.

A related method, biophysical classification (also called ecological classification) was then described by Dr. Michel Jurdant (Chief, Regional Ecological Studies, Environment Canada, Quebec). The basic concepts and objectives of this approach were detailed, and as an example the ecological survey of the James Bay Region was described. This survey resulted in maps at a scale of 1:125,000 containing information of value to forestry, engineering, recreation and wildlife management.

Professor Peter Murtha (UBC) then described the role of remote sensing in ecological classification. Remote sensing is a key tool in physiographic and ecological (biophysical) classification, and Dr. Murtha described the mapping of the island of Sulawesi. Present work indicates that satellite imagery can be used to delineate biogeoclimatic zones and, in some cases, subzones in B.C. Dr. Murtha also drew attention to the use of remote sensing to monitor the environmental effects of forest management.

One of the basic questions that must be asked in the classification and mapping of land is: what scale should be used? Professor Tom Damman (Univ. of Connecticut) presented a very useful discussion of the problems of scale in mapping. He showed the map scale necessary to depict various different types of vegetation units, and discussed in some detail the question of which vegetation criteria are useful in the recognition and delineation of different land units at different scales.

This section of the symposium concluded with a thoughtful paper by Professor Stan Rowe (Univ. of Saskatchewan) in which he compared different approaches to land classification. He noted that many of the products of such activity are not ecological maps, but only inventories of individual ecosystem components. He stressed the need to objectively define the criteria used to delineate the different land classification units in order that the utility of maps for different purposes can be judged. In closing, he noted that many of the differences between alternative approaches are more apparent than real. They relate to different scales and uses of the products of classification, and frequently arise because the same ecological unit has been given different names by different people.

ECOLOGICAL LAND CLASSIFICATION ELSEWHERE IN CANADA

The next section of the symposium was given over to a series of regional statements about the history and present status of ecological land classification. Dr. Satoru Kojima (then of the Canadian Forestry Service, Edmonton, now in Japan), described the current program of biogeoclimatic classification in Alberta which represents a continuation of the B.C. classification east of the Rockies. This was followed by a paper from Mr. Hugo Veldhuis (Canada-Manitoba Soil Survey) who described the variety of approaches to land classification that have occurred in Manitoba and Saskatchewan. In particular, he gave a detailed description of recent biophysical classification activities.

Dr. Dys Burger provided an overview of land classification in Ontario, complementing his earlier paper on the physiographic method. Similarly, Dr. Michel Jurdant expanded on his earlier discourse on the ecological (biophysical) classification method by describing activities in Quebec and the use of ecological inventories for environmental management. The method has gained wide acceptance in Quebec for major hydroelectric projects (such as the James Bay Development and St. Lawrence North Shore Area), park surveys, ecological reserves, forest zones and and various Ministry of Lands and Forests projects.

Prof. Gordon Weetman (Univ. of New Brunswick), reported that relatively little work has been done in the Maritimes subsequent to Loucks' 1962 publication of the ecoregions and districts of the area. Dr. Weetman reviewed the history of the forests of New Brunswick and Nova Scotia which has resulted in a forest condition and economic climate that has not been conducive to the identification and mapping of ecosystem units. Economic constraints continue to impede increased classification activity in spite of growing pressures for intensification of forest management.

Ecological classifications of forest lands in Newfoundland and Labrador were reviewed by Mr. Ken Beanlands (Assistant Deputy Minister of Lands, Government of Nfld. and Labrador). This comprehensive paper described the physiography and vegetation of the Province and then detailed an extensive history of classification activities. The application of Damman's classification in forest management was reviewed in some detail.

The final Canadian regional report was given by Dr. Steve Zoltai (Canadian Forestry Service, Edmonton) who described ecological classification in northern Canada. This vast area incorporates a wide variety of physiography, from the highest mountains in Canada to featureless arctic plains. A variety of classifications of northern areas have been undertaken, mainly at a small scale; most have been associated with northern resource developments and because of the vast areas involved most have used the biophysical approach.

ECOLOGICAL LAND CLASSIFICATION ACTIVITIES IN THE PACIFIC NORTHWEST STATES

Ecological classification in Oregon and Washington had the same origin as that in British Columbia: the work of Spilsbury and Smith in the 1940's. The subsequent histories of activity in the two areas have shown a continued parallelism: the work of Krajina in B.C. is mirrored south of the 49th parallel by that of Daubenmire, and as with Krajina's work, Daubenmire's forest habitat classification has only recently been accepted and applied by resource managers.

Dr. Jerry Franklin (Chief Plant Ecologist, U.S. Forest Service, Oregon), described the present status of the extensive ecological classification work presently being conducted in Oregon and Washington. Forest ecologists have been assigned to each of the six National Forest Areas within these two states to carry out detailed classification work emphasizing the plant community. The classifications are in daily use by resource managers.

The production of detailed site maps is not an objective of the program, reflecting a philosophy similar to that of the B.C. Forest Service. Additional classification work is being done by the National Parks Service, while another approach (environmental factor 'classification') has been developed in southwestern Oregon. This paper gives a good overview of what is happening to the south of B.C.

A description of what is happening further east (Idaho and Montana) was provided by Dr. Robert Pfister (Principal Plant Ecologist, U.S. Forest Service, Utah). He reviewed the application of vegetation (habitat types), soil and physiographic classification approaches in this region. He noted that the U.S. Forest Service have already faced up to the need to develop a uniform language and hierarchical classification of land. Their solution was to recognize that vegetation and physiographic mapping involves independent but complementary hierarchies. No single classification could be found that was desirable or feasible on the basis of existing knowledge. The best that could be done was to establish the relationship between the different hierarchies. Dr. Pfister noted the need for a clear statement of objectives and a clear analysis of the types of information necessary before one develops a new classification or chooses between two alternative existing classifications. Usefulness in application will be the ultimate test of the *best* approach, not the theoretical elegance of the classification. He admonished us to, 1) maintain objectivity and honesty, 2) practice humility, 3) document criteria of classification, and 4) get the land classified. Good advice!

CONCLUDING PAPERS

The symposium concluded with brief statements by Professor Weetman and Dr. Don Minore (U.S. Forest Service, Oregon) on the current revision of *Forest Cover Types of North America* The rationale for the revision and methods being used were outlined, and a brief statement was made concerning Canadian involvement. Canadians are reviewing descriptions of cover types that occur in both the U.S. and Canada, and preparing descriptions of types that are exclusively Canadian.

The final statement was made by Mr. Jean Thie (Chairman, CCELC) who presented a brief history of the Canada Land Inventory, the development of the national biophysical and wetland classification systems and the genesis of the Canadian Committee on Ecological (Biophysical) Land Classification. Mr. Thie described the objectives and organization of the Committee, *(To encourage the continued development and application of a uniform approach to ecological land classification for purposes of resource planning, management and environmental impact assessment)* and noted that the Committee provides a permanent forum for discussion and evaluation of approaches to ecological land classification.

CONCLUDING REMARKS

The symposium was a success judging by attendance figures, the quality of the papers and comments

received. It appears to have served the intended purpose of stimulating mutual discussions between the different classification approaches in B.C., and hopefully has contributed to a broader understanding of the *status quo*. The symposium did not, nor was it intended to, settle any of the contentious issues; these must be solved by continued discussion and debate, such as is being done in the present meeting, and by field evaluation.

REPORTS BY PROVINCIAL REPRESENTATIVES

RAPPORTS DES REPRÉSENTANTS DES PROVINCES

ECOLOGICAL (BIOPHYSICAL) LAND CLASSIFICATION ACTIVITIES IN SASKATCHEWAN

A. G. Appleby
Land Use Division
Resources Branch
Department of Northern Saskatchewan
Prince Albert, Saskatchewan

ABSTRACT

A review of ongoing and planned land classification projects in Saskatchewan is presented. These include wildlife habitat inventory, forest land classification, Qu'Appelle Valley land use planning, northern Saskatchewan development strategies, the Churchill River study and Poplar River Wildlife Study. Biophysical land classification and land capability assessment for Indian Band entitlements are also discussed. (Ed. Abstr.)

RÉSUMÉ

Survol des travaux en cours et des projets dans le domaine de la classification des terres en Saskatchewan. Ces projets et travaux visent notamment l'inventaire des habitats de faune, la classification des terres boisées, la planification de l'occupation des terres dans la vallée de la Qu'Appelle, l'élaboration des stratégies d'aménagement du nord de la Saskatchewan, et la réalisation des études sur le Churchill et la faune de la rivière Poplar. Il est aussi question de classification biophysique et d'évaluation du potentiel des terres imparties aux bandes indiennes. (Rés. Éd.)

INTRODUCTION

This paper will present the range of land classification activities now going on and planned in the Province of Saskatchewan. The broadest range of land classification studies, and instances of use and application of ecological land classification information in practical planning, problem solving and decision making are outlined. Because of the broad nature of the approach, the paper will not attempt to go into detail on the specifics of individual studies. Two background papers to be presented to this meeting have been submitted from work ongoing in Saskatchewan, and will give a detailed account of their specific applications. Places named in the text may be found on the map in Figure 1.

PROVINCIAL GOVERNMENT ACTIVITIES

Several agencies of the Saskatchewan Government are currently directly involved in land classification activities. The Department of Tourism and Renewable Resources has been responsible for the bulk of the ongoing land classification activities since the first meeting of the CCELC. The Fisheries and Wildlife Branch, Wildlife Research Unit in Saskatoon, has been engaged for several years in a land and habitat classification for wildlife in the southern half of the province, which is generally the agricultural area. The wildlife habitat inventory is aimed at a broad comprehensive appreciation of land types, to assist in planning the preservaton and management of wildlife habitat. Three kinds of information have been mapped at 1:250,000 on four part overlay maps with accompanying descriptive reports. This work is being presented to the meeting in a background paper entitled *Terrestrial Wildlife Habitat Inventory of Agricultural Saskatchewan* authored by Hart et al (1979).

Another group active in land classification is the Department of Tourism and Renewable Resources, Forestry Branch. Their work on forest land classification covers the commercial forest region in the southern half of Saskatchewan and will be presented in a background project report paper entitled *Ecological Forest Land Evaluation in Saskatchewan,* authored by W.C. Harris and A.L. Kosowan (1979) This work is mainly involved in classification of forest ecosystems and land systems, and their implications in forest management.

Work has been carried out by the Department of Municipal Affairs under the Canada-Saskatchewan Qu'appelle Agreement, which provides for a program of land use planning and development controls in the Qu'Appelle Valley. Through the past two years, staff of the Land Use Planning Team and representatives of local government and special interest groups, have worked on a program to control poorly planned development and to involve local municipalities and special interest groups in decisions on land use. A classification study was under-

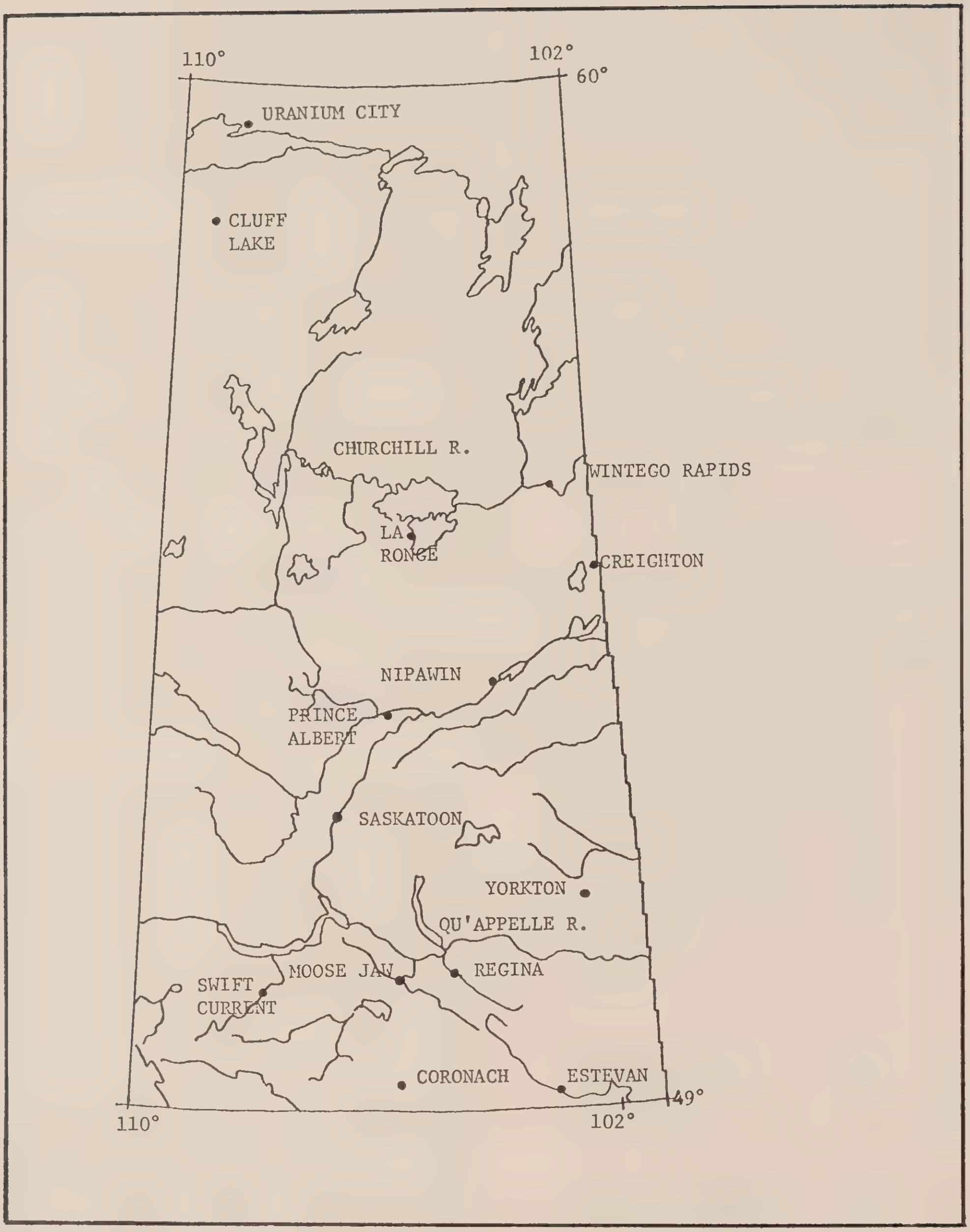


Figure 1: Province of Saskatchewan showing location of places identified in the text.

taken by a consultant which outlined development type characteristics and analyzed the various landscape units in the valley complex (Hilderman et al, 1977). IBP area descriptions were used for zoning some natural areas. Wildlife zones and flood plain designation were based on land classification studies. For this, the wildlife habitat inventory previously referred to was adapted to the study. On the basis of existing land use and land classification studies, six special planning areas have been delineated as legal entities in the valley. All developments must be approved by a Special Planning Area Commission in accordance with the zoning maps and regulations. these zones and regulations have been erected partly as a result of the land classification studies. In the meanwhile, work continues towards a more comprehensive long-term land use plan for the valley.

Land classification studies in Northern Saskatchewan have mainly been undertaken to date, in response to major development proposals, as a part of environmental impact assessment or project planning studies. There now exists in the Resources Branch of the Department of Northern Saskatchewan, a Land Use Division, which has among its responsibilities regional and resource allocation planning, and comprehensive recreation planning in the Northern Administrative District (approximately the northern, generally forested, half of the Province). It is expected that this group will be undertaking some new, broadly based biophysical land classification studies on large areas of the North, as an aid to regional strategic planning and resource allocation and management.

PROJECT ORIENTED ACTIVITIES

Several major land classification studies have been undertaken in response to the need for information on which to base decisions concerning major development projects. Perhaps the most massive effort in this regard has been the Churchill River Study, which produced its reports throughout 1975 and 1976. The total study was a cooperative Saskatchewan-Canada-Manitoba effort. The Saskatchewan study sectors included land classification aimed at illustrating the geology, forestry, recreation, and wildlife of the study area along the Reindeer and Churchill Rivers. Wildlife habitat was mapped and classified to nine general types from maps and aerial photographs (Barber, Stelfox and Boden, 1975). Recreation classification was based on the Canada Land Inventory (CLI) system at a scale of 1:50,000 through field reconnaissance, air photos, and forest inventory maps (Larsen and McKay, 1975). The information was the basis of an assessment of the impact of development of a major hydroelectric development on the Churchill River at Wintego Rapids. This evaluation, published in 1976, is currently before the Churchill River Board of Inquiry which held hearings in 1977 and 1978, to gather public opinion on the proposal. The Board is preparing a report for release this summer, with its recommendations based on all the evidence to date.

A similar environmental impact-oriented exercise is currently underway by the Poplar River-Nipawin Power Generation Board of Inquiry. This inquiry is undertaking a detailed examination of the environmental impact of two proposed alternative power generation schemes, one a hydro-electric development on the Saskatchewan River near Nipawin, and the other a coal fired thermal plant on the Poplar River, near Coronach, in the south of the Province. The Nipawin study area covered 180 km^2 in the valley of the Saskatchewan River. The wildlife and natural history report contains a biophysical land classification covering land forms, plant communities and types, canopy cover, mammal habitat and avian features (Blood et al, 1977). The recreation report follows CLI methodology modified to produce more detail for the small study area, and to include a feature significance value (Freund, 1977).

The Poplar River Wildlife Study covered an area of 465 km^2, and produced a biophysical land classification which combined landform, hydrology, land uses and plant cover into a single class system with six physiographic types and seven cover types. Wildlife species designations were applied to map units (Blood, Anweiler and Polson, 1976). These sets of reports are currently open to public meetings. Later this year, public hearings will be held on the basis of the information produced to allow the Board of Inquiry to make recommendations on the power development projects.

A study just underway involves the road corridor to the proposed Cluff Lake uranium development in northern Saskatchewan. This proposed mine development was examined through extensive public hearings held last year under Mr. Justice E. D. Bayda, concerning the potential environmental impact of such development. If built, the Cluff Lake road will open access to the west side of the northern third of the Province. The study now underway will include a resource inventory and capability classification of the corridor. The legend proposed will incorporate the United States EPA Corridor Legend, the Forest Management Institute Legend (Environment Canada) and the Canada Land Inventory format. The method of classification will be similar to the Inuit Corridor Study for the Berger Commission and the Churchill River Study previously men-

tioned. These studies will be used in the production of a detailed plan for future land use in the transportation corridor, a band some 20 kilometers wide. The study is being prepared by the Saskatchewan Research Council for the Department of Northern Saskatchewan.

TREATY INDIAN LAND ENTITLEMENTS

The Government of the Province of Saskatchewan, the Government of Canada and the Federation of Saskatchewan Indians reached agreement in 1977 regarding unfulfilled Treaty Land Entitlements. Fifteen Indian bands will receive a total of approximately one million acres, to be selected from unoccupied Provincial Crown Lands, wherever such lands are suited to the needs of the Bands. Certain federal crown lands were also to be made available. Entitlements are based on the original Treaty obligations and the Band populations as of 31 December 1976. 1976. A land selection planning process has been outlined by the Federal Department of Indian and Northern Affairs, to assit the bands in making their choices, and for developing land and resource utilization plans within the context of overall band community planning processes.

A major part of this process will be the data acquisition steps, including land classification and capability inventory. This is done first on a very general basis using existing information and opinion for lands in which the bands may be interested. Having developed a reasonable data base on a general area for land selection, more detailed studies will be undertaken. Large-scale maps and land classification reports will be produced which will describe, in detail, land capability units, development potentials and recommendations. This information will, in all probability, be prepared by private consultants and oriented towards economic and resource use potential. After land selections have been made and ratified, the information will serve further in the production of comprehensive community plans for the bands.

FUTURE STUDIES AND ACTIVITIES

Future significant land classification activities may result from decisions now pending on uranium mine development, to be considered in the report of Justice Bayda expected shortly. A positive conclusion will give impetus to uranium exploration and development, and to the need for access to development areas. For instance, studies similar to those beginning on the Cluff Lake Road may be necessary if access were to be developed to the Key Lake deposits in North Central Saskatchewan.

Once the report of the Churchill River Board of Inquiry is made public, and decisions taken on power development on the Churchill, there will undoubtedly be necessary follow-up. A great deal of work has been done in land classification during the previous Churchill River Study. If power development is delayed or negated, the studies may be used to pursue other developments in the Churchill Basin, particularly for recreation. The exact nature of such follow-up will depend to a great extent on the report of the Board of Inquiry.

There is currently a trend to undertake biophysical land classification studies and apply the results in practical situations to enlarge the information base and facilitate evaluation of the effects of major development. This is an aid to better decision making. Biophysical land classification studies are also being developed to aid in habitat identification and evaluation and resource management in the Province of Saskatchewan. It would appear that increased activity is likely in this field in coming years.

REFERENCES

Barber, S.R., H.A. Stelfox and J.D. Boden. 1975. Churchill River Study: Wildlife. (Saskatchewan). Final Report 28, prepared by Saskatchewan Department of Tourism and Renewable Resources for Churchill River Study (Missinipe Probe). 272 p.

Blood, D.A., G.G. Anweiler and J. Polson. 1976. Wildlife Impact Study - Poplar River Thermal Power Project. Final Report Donald A. Blood and Associates for Saskatchewan Power Corporation. 170 p.

Blood, D.A., et al. 1977. Proposed Nipawin Hydroelectric Project. Wildlife and Natural History Report. Donald Blood and Associates. for Saskatchewan Power Corp. 99 p.

Freund, G.H. 1977. Proposed Nipawin Hydro-Electric Project. Outdoor Recreation. Saskatchewan Research Council. for Sask. Power Corp.

Harris, W.C. and A.L. Kosowan. 1979. Ecological Forest Land Evaluation in Saskatchewan. Proc. 2nd Meeting Can. Com. Ecol. Land Classif. (comp. and ed. by C.D. Rubec) Ecol. Land Classif. Series No. 7, Lands Directorate, Environment Canada, Ottawa.

Hart, R.T., S.R. Barber., G.W. Pepper, and H.A. Stelfox. 1979. Terrestrial Wildlife Habitat Inventory of Agricultural Saskatchewan. Proc. 2nd Meeting Can. Com. Ecol. Land Classif. (comp. and ed. by C.D. Rubec)

Ecol. Land Classif. Series No. 7. Lands Directorate, Environment Canada, Ottawa.

Hilderman, M.G. et al. 1977. A Stragegy for Land Use Planning in the Qu'Appelle Valley Last Mountain Lake - Flying Creek Area. Report prepared for Qu'Appelle Implementation Office, Department of Municipal Affairs. Hilderman Feir Witty and Associates. 77 p.

Larsen, R.H. and D.S. McKay. 1975. Churchill River Study. Recreation (Saskatchewan) Final Report 18. Institute for Northern Studies, University of Saskatchewan for Churchill River Study (Missinipe Probe). 134 p.

AN ECOLOGICAL CLASSIFICATION PROJECT FOR THE ONTARIO PORTION OF THE HUDSON BAY-JAMES BAY REGION

A. N. Boissonneau and S. Pala
Ontario Centre for Remote Sensing
Ministry of Natural Resources
Toronto, Ontario

ABSTRACT

This paper outlines the classification philosophy and the field and office procedures which will be used for a Ministry of Natural Resources project to map and describe the wetland ecosystems of the Ontario portion of the Hudson Bay-James Bay Region. The objectives of the project are summarized and the relationship of this project to other projects and previous work is considered.

The primacy of vegetation as an indicator of the resultant of all wetland ecosystem processes is stressed. Also, the value of LANDSAT imagery as a means to a 'from above' classification method is emphasized.

RÉSUMÉ

Ce document décrit les principes de classification et les méthodes à utiliser sur le terrain et dans les bureaux pour le projet du Ministère des Ressources Naturelles visant à cartographier et décrire les écosystèmes des terres mouillées de la partie ontarienne de la baie d'Hudson et de la baie James. On y trouve un résumé des objectifs du projet ainsi qu'une étude des relations existantes entre ce dernier et d'autres projets et travaux antérieurs.

On met l'accent sur l'importance primordiale de la végétation en tant qu'indicateur de la résultante de tous les processus relatifs aux écosystèmes des terres mouillées. On fait également ressortir la valeur des images LANDSAT en tant que méthodes de classification 'au-dessus'.
(Trad. Éd.)

INTRODUCTION

During the current 1978 field season, the Ontario Centre for Remote Sensing will initiate the ecological classification of wetlands in the Hudson Bay-James Bay Lowland region of Ontario of which 90% of the land area is wetland.

The purpose of this project is to provide a level of mapping and description of wetland ecosystems that will be useful to wildlife management, land use planning and the assessment of the environmental impact of development. As no single level of ecological classification can meet all these needs it will, in effect, be a level of mapping and description of patterns of wetland ecosystems which balances user needs against what is a practical program in terms of funding, time, personnel and contemporary technology. The minimal objectives of this project are, therefore, as follows:

1. To provide a synoptic overview of the ecosystem patterns of the entire region which will be useful in highlighting ecosystem patterns which would have significantly different wildlife habitat values and different responses to a particular kind of development manipulation.

2. To provide an overall framework of wetland ecosystem patterns which will be useful in the planning of more intensive levels of ecosystem study in small areas and in extrapolating the results of these studies.

In addition to these minimal objectives, in many areas propitious combinations of factors will permit the mapping and description of a surprisingly detailed level of ecosystem description. More detail about these "propitious combinations" will be given later in this paper.

At this point, those familiar with the work which has already been completed in this region might be wondering if Bates and Simkin had not already achieved these objectives for most of the region in 1969 when they published their 1:633,600 scale map, *Vegetation Patterns of the Hudson Bay Lowlands*. The main reason why these objectives were not attained in 1969 is that wetland ecosystems form too intricate a mosaic to be meaningfully complexed into map units which are large enough to be practical for a 1:633,600 scale of mapping. Each map unit must necessarily include a large number of 'bedfellows', many of which seem 'odd' indeed in relation to the types by which the unit is named. The authors are confident that the project outlined in this paper, on the other hand, *will* achieve its objectives because the map scale employed is 2½-times larger (1:250,000), because each map will be supplemented by a comprehensive report (an outline of these reports is given later in this paper), and because the technology of remote sensing has advanced considerably since 1969.

RELATIONSHIP OF THIS PROJECT TO RELEVANT WORK IN NORTHERN ONTARIO

The first consideration in this section is the relationship of this wetlands project to the Ontario Land Inventory program for Northern Ontario. As indicated in Figure 1, the area of study of this wetlands project lies far to the north of the OLI study area and hence these two studies will provide two separate sources of ecological data.

The second consideration is the relationship of this project to a program of surficial geology mapping initiated in April 1977 by the Ontario Centre for Remote Sensing together with the Ontario Division of Mines. As indicated in Figure 1, the study area of this program embraces all of the Precambrian Shield portion of Northwestern Ontario north of the area covered by the surficial geology maps of Zoltai (1965) and includes the map area of Prest (1963). The Prest study area was included in order to map this area at the uniform level of detail of surficial geology for Northern Ontario. A surficial geology map is not an ecological land classification map but it is a very useful precursor of such a map. This project will delineate a practical boundary between the Precambrian Shield and the Hudson Bay-James Bay Lowland. This boundary will then be used to define the western and southern boundaries of the OCRS wetland project.

The third consideration is a project of Environment Canada in the coastal zone of the Lowlands. This project is outlined by Cowell, Wickware and Sims (1979) in the proceedings of this meeting. They used LANDSAT colour composite images to delineate the coastal zone of the Ontario portion of the Lowlands. They will study the coast from the intertidal flats to their coastal zone boundary and the OCRS wetland project will study the areas from the coastal zone boundary inland to the Lowlands-Precambrian Shield contact. Hence, the study areas of these two projects do not overlap. Also, the fields of study do not overlap since the coastal project will deal with mineral soil sites and young fens, while the wetlands project will deal with deep bogs and mature fens.

The last consideration is an OCRS project to produce *The Physiography of Northern Ontario*. This will be a companion volume to Chapman and Putnam (1973). The data sources for this work will be the OLI land classification maps, the OCRS-ODM surficial geology maps and the OCRS wetland maps. The area of Northern Ontario is 902,337 km^2 while the area of Southern Ontario is 163,938 km^2. There is also a vast difference in the practical possibilities of field checking in the two parts of Ontario. In Southern Ontario, there are tiers of roads spaced about 1.4 km apart, while in Northern Ontario the road systems are rudimentary or aircraft must be employed to obtain access to sampling locations. These differences will necessitate the use of a broader level of physiographic feature description than was used in the data published for Southern Ontario.

THE WETLANDS CLASSIFICATION

The wetland classification framework which will be used is that of Jeglum et al (1974). There can be no a priori answer to the question of the level or levels of the hierarchic classification framework which will be employed for this project. The levels of the framework which are used will depend upon the distribution pattern of the wetland ecosystems, the distinctiveness of their signatures on various combinations of LANDSAT imagery and the available resources of remote sensing technology. For example, a certain combination of LANDSAT imagery of different seasons and different spectral bands may provide a distinctive signature for a particular dominance type or site type (a wetland type of the most detailed level of the classification hierarchy). On the other hand, because of a very intimate association of types, it may be necessary to map a pattern of formations (a pattern of wetland types of the most generalized level of the classification). Since any level of detail which it is possible to obtain

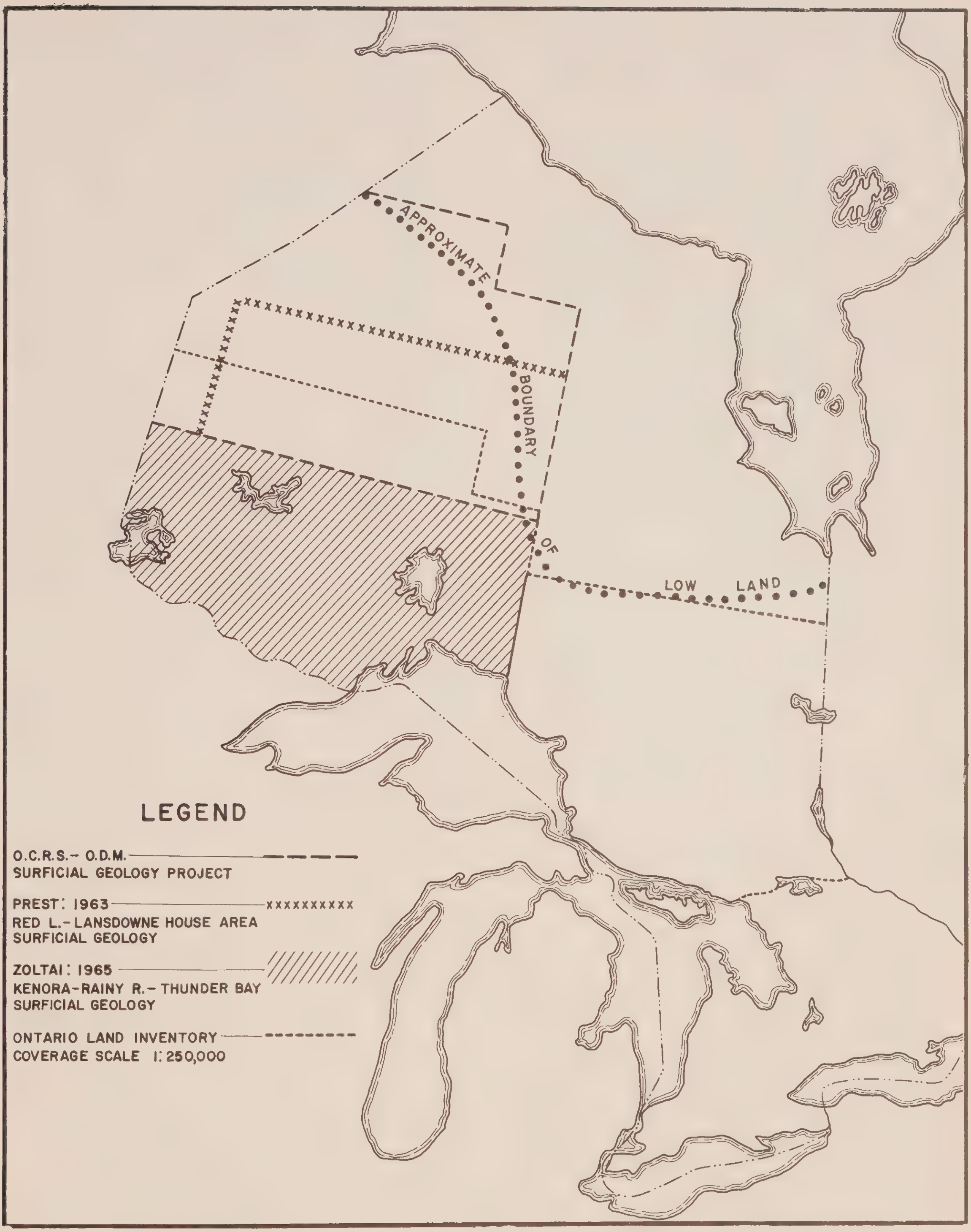


Figure 1: Locations of Land Classification Surveys in Northern Ontario

would not be sacrificed merely to achieve a consistent level of classification throughout a map area. The full spectrum of types and patterns used in mapping will not be known until the area has been mapped.

Another source of variation in the mapping is the choice of the *chorologic map units* to be used. Chorologic map units are units which are designed to best serve the purposes of the users of the map. For example, patterns of wetlands and water bodies are convenient map units for evaluating habitat for nesting geese. Consequently, a chorologic map unit combining wetland types and associated water bodies is required. Lichen is an important food source for Caribou. Hence, lichen, when abundant, would be designated along with the dominant vegetation species or physiognomic group (an open, low shrub-lichen bog, a *Betula glandulifera*-lichen-patterned fen). Permafrost is a significant constraint to development; therefore permafrost landforms such as peat plateaus, palsas or patterned ground would be added to the wetland type designation.

The choice of chorologic units for any specific map area will be unique for that area since it will depend on the particular features found in the area which are deemed to be significant in the fields of interest of the map users.

METHODS

Field Methods

Preliminary work prior to the field season will involve, initially, a study of the wetland patterns of the 1978 work area. These patterns are most readily seen on LANDSAT colour composites for various times of year. Then, on the basis of this study, specific ground study locations will be selected. These ground study locations are chosen on the basis of the following objectives:

1. To sample the whole range of patterns which were observed in the preliminary study.
2. To sample the dominant patterns of each LANDSAT scene. Often atmospheric conditions or differences in the colours assigned to the three bands of the composites of adjoining scenes can cause apparent differences in the appearance of the wetland pattern on Landsat imagery. Field study will then indicate that these are the same wetland type. Also, wetlands with similar reflectances on adjoining LANDSAT scenes may prove to be different when studied in the field. For example, an open graminoid bog on the LANDSAT image of an area having no permafrost may have a similar reflectance to a Sphagnum-Lichen peat plateau on an image of an area with permafrost landforms.
3. To replicate many times the commonly-occurring wetland types on each LANDSAT scene. If the ground data indicates early in the traverse that patterns judged to be similar are, in fact, consistently the same wetland types, the number of these replications can then be considerably reduced.

In addition to the ground study locations for wetland patterns which have recognizable but unidentifiable components and for other patterns where large-scale colour images would appear helpful, a flight plan for 70 mm colour photography will be drafted to photograph representative strips through these types. When the field study locations have been selected, daily helicopter itineraries will be compiled for each base location. The objective in drafting these itineraries is to design flight lines which will most efficiently provide access to the ground study locations.

The field party will consist of John Riley, a botanist with the Royal Ontario Museum; Andrew Cooper, a geologist with the Ontario Division of Mines; John Narraway of OCRS, who will supply logistical support; and the authors of this paper. A Jet Ranger helicopter will be leased for one month of the field season to provide access to the field study location and for low-level aerial reconnaissance of selected areas. A Geophysical Survey Systems impulse radar system will be leased from Memorial University, Newfoundland for permafrost and subsurface investigations.

At each field study location, the vegetation cover, peat stratum, soil water and permafrost features will be investigated. The species of each vegetation stratum will be noted and specimens will be collected as required to confirm field identifications or to provide species identifications. Vegetation types at all levels of the Jeglum et al (1974) classification will be noted in the field.

For the peat layer, the depth of peat will be established and the dominant species of the living peat stratum will be identified. The degree of peat deposition of what appears to be the modal type of peat will be evaluated using the Van Post method.

For the soil water, the depth to water table, the pH, and the conductivity of standing soil

water will be measured. These pH and conductivity measurements will be contrasted with the similar measurement for the water which is loosely held in the peat.

Permafrost will be investigated using impulse radar and a permafrost borer. The purpose of this work will be to test the utility of impulse radar in determining permafrost depth and in indicating the thicknesses of the different soil materials which form the permafrost layer. Since determination of permafrost depths and soil material types with a permafrost borer are time consuming, it is hoped that with a limited amount of permafrost borer data, the impulse radar method can be used to determine these parameters from differences in the electrical properties of soil materials of different textures and of frozen and unfrozen soil material.

If it is possible, the nature of the surficial materials underlying the peat will be determined. This data is not required for the wetland classification since the underlying surficial materials rarely have any influence upon the development of wetland ecosystems. However, the data might be helpful in elucidating the glacial history of these areas.

Preparation of the Maps

The boundaries of wetland types which are interpreted on LANDSAT colour composite images as distinctive patterns of wetland ecosystems, and certain environmental features, can be delineated directly on the 1:1,000,000 scale LANDSAT imagery. These lines would then be transferred to maps of the publication scale (1:250,000) using a Zoom Transfer Scope. The environmental features recognized in these patterns are such features as permafrost, lichen and waterbodies which are important for evaluation of land use capability and development constraints of land, and such features as peat depth, water chemistry and peat decomposition, which are relatively constant for each wetland type within a specific wetland region.

For map areas which were judged to be relatively homogeneous from their appearance on the colour composites, and which fieldwork also indicated had a uniformity of biotic and environmental features on the ground, no further work is required to complete their mapping and description. For areas which were recognized as patterns of wetland ecosystems on the LANDSAT imagery, and for areas which, though they were judged relatively uniform by their appearance on the LANDSAT imagery, proved in the field to be a pattern of ecosystems or a pattern of biotic and environmental features, further analysis will be required to study these patterns.

As examples of these analyses, the percentage of area comprised of waterbodies within a map area can be obtained very accurately from the infrared bands of LANDSAT imagery using analogue or digital analysis. The proportions of graminoid bog and low shrub bog in an open bog map unit could be obtained from a summer LANDSAT image using digital or analogue analysis techniques. In some analyses of map unit components, the reflectance values of these components on a single LANDSAT scene may be so similar that they cannot be distinguished. In such cases, the OCRS AP3 Analogue Encoder would be used to provide a composite image composed by superimposing LANDSAT images of the same scene at different seasons or different combinations of LANDSAT bands and different seasons. These composite images would then be analysed to provide distinct signatures for the components being studied. For ecosystem patterns having very intimately associated components, the OCRS will have a NORPAK RGP 3050 Digital Image Analysing System operational by the 1978-79 office season to permit analyses of the approximately 0.45 ha picture elements of LANDSAT imagery.

Reports will be prepared for each of the map sheets describing the biotic and environmental features of the map areas and summarizing the proportional occurrence and environmental and biotic characteristics of the major components of the map areas. The observations of each field study location within each map sheet will be summarized in an appendix to these reports.

Finally, manuscript maps of the wetland types will be prepared for the 14 part or whole map sheets which comprise the 1978 field area.

DISCUSSION

This methodology accepts the premise that the vegetation of a wetland ecosystem is the best indication of all the transactions among the biotic and environmental features of the ecosystem. Wetland landform and wetland hydrology have very significant influences upon the development of wetland ecosystems. However, on the flat landscape of the Lowlands, even as studied on the ground, these influences must be inferred from the vegetation patterns rather than pattern of relief and water movement.

As examples, a change from stunted black spruce-treed bog to black spruce of commercial size in a swamp will indicate a changed slope pattern

which is very difficult to demonstrate by differential levelling. The presence of such ground vegetation as *Betula glandulifera Catha palustris, Menyanthes trifoliata and Potentilla palustris* and absence of *Sphagna* spp. are indications of water flow which would be difficult to demonstrate by hydrological techniques.

In addition to its usefulness as an indicator of the resultant of ecosystem transactions, vegetation is *the* feature of wetlands which is responsible for the radiation reflectance from a wetland. Consequently, the reflectance values of a wetland recorded on LANDSAT imagery are a function of the type of vegetation of which the wetland is composed. Thus, vegetation is, both from an ecosystem and an ecosystem interpretation viewpoint, the logical feature to use in classifying wetland ecosystems. All other ecosystem features, therefore, are to be used as descriptive adjuncts.

The saving of time and effort which is involved in this methodology of 'classification from above' should be appreciated. LANDSAT imagery provides a synoptic overview of distinctive patterns of wetland ecosystems. Consequently, a study of LANDSAT imagery will provide a delineation of practical wetland map units which will survive with only minor alterations to the final published map. If LANDSAT imagery were not available, it would be necessary to build up the distinctive wetland patterns 'from below'. This would involve a laborious, time-intensive study of innumerable medium-scale (1:60,000) air photos. Also, results of the process of agglomerating distinctive wetland patterns, by projecting wetland pattern boundaries from strip to strip or across mosaics which spread over walls and across ceilings, can be uncertain. This uncertainty results from the perspective of a fly on Da Vinci's *Mona Lisa*, the variation in the overall tonal values of the air photo from strip to strip and, even worse, a sequence of strips showing lightly snow-covered terrain surrounded by a ground mass of strips showing terrain in midsummer. Consequently, both from efficiency and quality of work standpoints, the methodology of classification from above has marked advantages over the methodology of classification from below.

The 'ready-made' delineations of distinctive wetlands patterns provided by LANDSAT imagery permits the choice, on each scene of imagery, of sample locations of a number of replications of each widespread wetlands type or each major component of complexed types. These selected field study locations would be distributed more or less evenly throughout the scene. As field work proceeds, if ground investigations indicate a uniformity of vegetation and environmental features, the number of remaining replications of study locations need not be visited. On the other hand, if field investigations indicate a variation of ecosystem features within a wetland type, or a wetland component, additional field study locations may be chosen to provide a firm basis for the subdivision of the type or components. This flexibility of execution of the field work, and the growing confidence in the adequacy of the field data as the fieldwork proceeds, assures that the fieldwork phase can be completed efficiently with the minimum of effort required for an adequate data output. This efficiency is very important in the Lowland where access to all field study locations is via helicopter at $430. per hour.

It is inferred above that a separate ground truthing scheme would be planned for each LANDSAT scene. Experience has shown that this is the best plan to follow since compensation of factors and introduction of variances due to differences in atmospheric conditions and differences in the kind of natural phenomena which are imaged from scene to scene make it inadvisable to extrapolate field data beyond the scene in which it is located. Although, superficially, this might seem to involve duplication of effort, when it is realized that ground truthing for a LANDSAT scene will provide a basis for describing the wetland types and components for an area of approximately 30,000 km^2 or approximately the combined area of 160 nine-by-nine-mile townships, it will be conceded that little duplication of effort is involved.

REFERENCES

Bates, D.N. and D. Simkin. 1969. Vegetation Patterns of the Hudson Bay Lowlands. Ont. Dept. Lands and Forests. Map 3269.

Cowell, D.W., G.M. Wickware and R.A. Sims. 1979. Ecological land classification of the Hudson Bay Lowland coastal zone. Ontario. *in* Proc. 2nd Meeting Can. Comm. Ecol. Land. Classif. Victoria, B.C. April 3-7, 1978. Lands Directorate, Environment Canada.

Chapman, L.J. and D.F. Putnam. 1973. The Physiography of Southern Ontario, Second Edition. University of Toronto Press, 386 p.

Jeglum, J.K., A.N. Boissonneau and V.F. Haavisto. 1974. Towards a Wetland Classification for Ontario. Can. For. Serv. Inf. Rep. O-X-215. 54 p.

Prest, V.K. 1963. Red Lake - Lansdowne House Area, Northwestern Ontario, Surficial Geology. Geol. Surv. Can. Paper 63-6. 23 p.

Zoltai, S.C. 1956. Thunder Bay, Surficial Geology. Ont. Dept. Lands and Forests. Map S265.

Zoltai, S.C. 1956. Kenora-Rainy River Surficial Geology. Ont. Dept. Lands and Forests, Map S165.

ECOLOGICAL (BIOPHYSICAL) LAND CLASSIFICATION IN MANITOBA*

A. E. Borys
Manitoba Department of Mines, Resources and Environmental Management
Winnipeg, Manitoba.

G. F. Mills
Canada-Manitoba Soil Survey
Winnipeg, Manitoba

INTRODUCTION

Ecological has been defined as *"of, or having to do with the environments of living things or with the pattern of relationships between living things and their environments"* (Webster, 1971). In the context of land, ecological pertains to the relationships between all of the various environmental factors which influence land and its capability and suitability for supporting the multitude of uses of interest to man. Ecological land classification, therefore, refers to an integrated approach to land survey. Areas of land are classified according to their ecological unity. The classification process includes the description, the comparison and the synthesis of data about the biological and physical characteristics of the land. Although these characteristics have been enumerated many times by different individuals, usually such a listing includes climate, vegetation, soil, surface deposits and of prime importance their interaction over time in the landscape.

Manitoba, as many other regions of Canada, has long been involved in collecting data concerning land. Various kinds of land and land-based resource inventories have been undertaken to gain knowledge about land and its ecological relationships to the total environment. Although many of these studies are somewhat ecological in intent, the degree to which they satisfy the current definition varies. Many such inventories keyed on single resources e.g. wildlife, forest cover, surficial geology, groundwater etc. and were designed to answer specific questions or to solve specific problems. Other inventories such as soil surveys, although emphasizing a single element, were in fact more broadly based and could serve several purposes. Examination of most soil surveys shows that all of the environmental factors which are built into current ecological land classifications are also included on the soil maps. A soil survey is very much an ecological land classification but differs from the current definition in that the integration of ecologically related elements takes place in the soil rather than receiving recognition as separate components of the landscape.

The recognized values of more broadly based inventories guided the development of early attempts at biophysical land classification in Manitoba. In recent years, under the auspices of the National Committee on Forest Lands, Manitoba participated in a pilot study towards development of a national system of biophysical land classification (Zoltai et al, 1969). The various approaches were patterned after earlier work in Ontario (Hills, 1960) and in Australia (Christian, 1958). A uniform set of guidelines evolved from these studies (SBLC, 1969) but their application to mapping methodology varied somewhat with nearly every project. It was apparent, however, that biophysical land classification as developed to that point provided a mapping methodology of great usefulness, particularly at broad reconnaissance scales of inventory where no previous resource data existed.

CURRENT PROGRAM

In 1974, Manitoba initiated a program of biophysical land classification in remote northern and eastern portions of the province (Borys, 1976; Mills, 1976). We are currently involved with biophysical land classification at two levels, reconnaissance and detail (Figure 1).

Reconnaissance Scale

The reconnaissance scale land classification was implemented through the Northern Resource Information Program (NRIP) which was charged with the responsibility of developing a system of classification suitable for Manitoba conditions and serving local needs as determined by planners for various land resource uses. During 1974 a methodology was developed, two map areas were ground truthed and a system for presenting the ecological data finalized at the land system level and scale of 1:125,000 (Mills, 1976).

*Abstract/Résumé on/à page 77.

This methodology was applied through 1975 and 1976 terminating early in 1977 after the program was no longer cost-shared with the federal government. During the course of the NRIP program approximately 93,383 km^2 (36,493 square miles) within 9¼ N.T.S. map sheets were ground truthed and mapped. To date four map areas have been published, two are at the printers and three are in final stages of preparation. The field program was carried out at a rate and cost comparable to other ecological land surveys in Canada (Mills, 1976). Rate of publishing has lagged, however, due to only part time commitment of available professional staff for compiling of data.

Although there have been many requests for the published information, concrete examples in which the data has had an impact on development are difficult to cite. However, much of the reconnaissance scale information has not been available for sufficient time to fully evaluate its application. Some drawbacks to the approach lie in the map scale which is designed mainly to satisfy regional planning purposes and may be too small to serve many users interested in more detailed or site specific planning and eventual development. A further limitation to use of the data is that to date there are no readily available interpretations of the ecological data. As many users are non-discipline oriented, they find the complexities portrayed in ecological terrain data difficult to interpret.

Detailed Scale

Upon termination of the systematic program of reconnaissance scale land classification, the province shifted emphasis to recognize the need for data at more detailed scales close to settlements. Consequently, in 1977 three pilot areas were studied in eastern Manitoba; one around the settlement of Cross Lake, one at Garden Hill on Island Lake and the third in the Whiteshell Provincial Park. The basic precepts of an ecological land classification system were maintained but a number of adjustments were made in the general approach to the program. It was agreed that each *project* would be custom planned consistent with ecological land classification methodology but would respond to specific pre-determined requirements of a particular user or combination of users. It was also agreed that the information supplied would include interpretation of the physical data for certain identified uses i.e. each report and map produced, although having a common theme and approach, would not contain interpretation for all possible disciplines.

The area chosen for analysis would be based on existing reconnaissance ecological maps or any other existing data where ecological maps do not exist. Thus the area to be mapped was considerably limited in size by initially excluding land obviously unsuited for the predetermined use or where development would likely take place only in the more distant future. Within the area selected for analysis the user would identify the specific interpretation required. In the case of the Cross Lake settlement, the user required interpretation of the land units for residential use, agricultural use as pertaining to horticulture, forage and grazing, forestry, and solid waste disposal. At Garden Hill, the user requirements were somewhat different and required interpretation for residential, agricultural and recreational use. It is conceivable that users in other communities will include other combinations of interpretations such as for sewage lagoons, wildlife, forestry, road locations, aggregate deposits, etc.

The specific methodology consists of preliminary air photo interpretation followed by a two week ground truthing field program for each community. Information is then transferred to a map at a scale of 1" = 500' (1:6000). Although it is possible to discern land phase units by stereo viewing of the aerial photos, the scale at which the information was being plotted was too small to accommodate the map symbols. Maps, therefore, show broad vegetation types corresponding to the land type level and primary, secondary and tertiary drainage classes.

The product available to the user includes a map at a scale of 1:6000 and a report. The map is a mosaic base with overlay of land units and symbols. Also included is an extended legend with symbol explanation and soil and vegetation data in tabular form. The report contains information on philosophy and methodology, map symbolization, engineering tests, shoreline analysis, representative site descriptions on mineral and organic soil land types and interpretations for various use capabilities. The report is replete with photographs, figures and illustrations.

Because the program is user-oriented it is anticipated the terrain analysis will have immediate application as has occurred with the first two projects, Cross Lake and Garden Hill. The primary user is the community planner who uses the information for preparation of a development plan for the community. Application of the information has had direct and immediate impact in such areas as preservation of land for recreation where capability is highest, in location of a solid waste disposal area and upon development of forestry harvesting practices

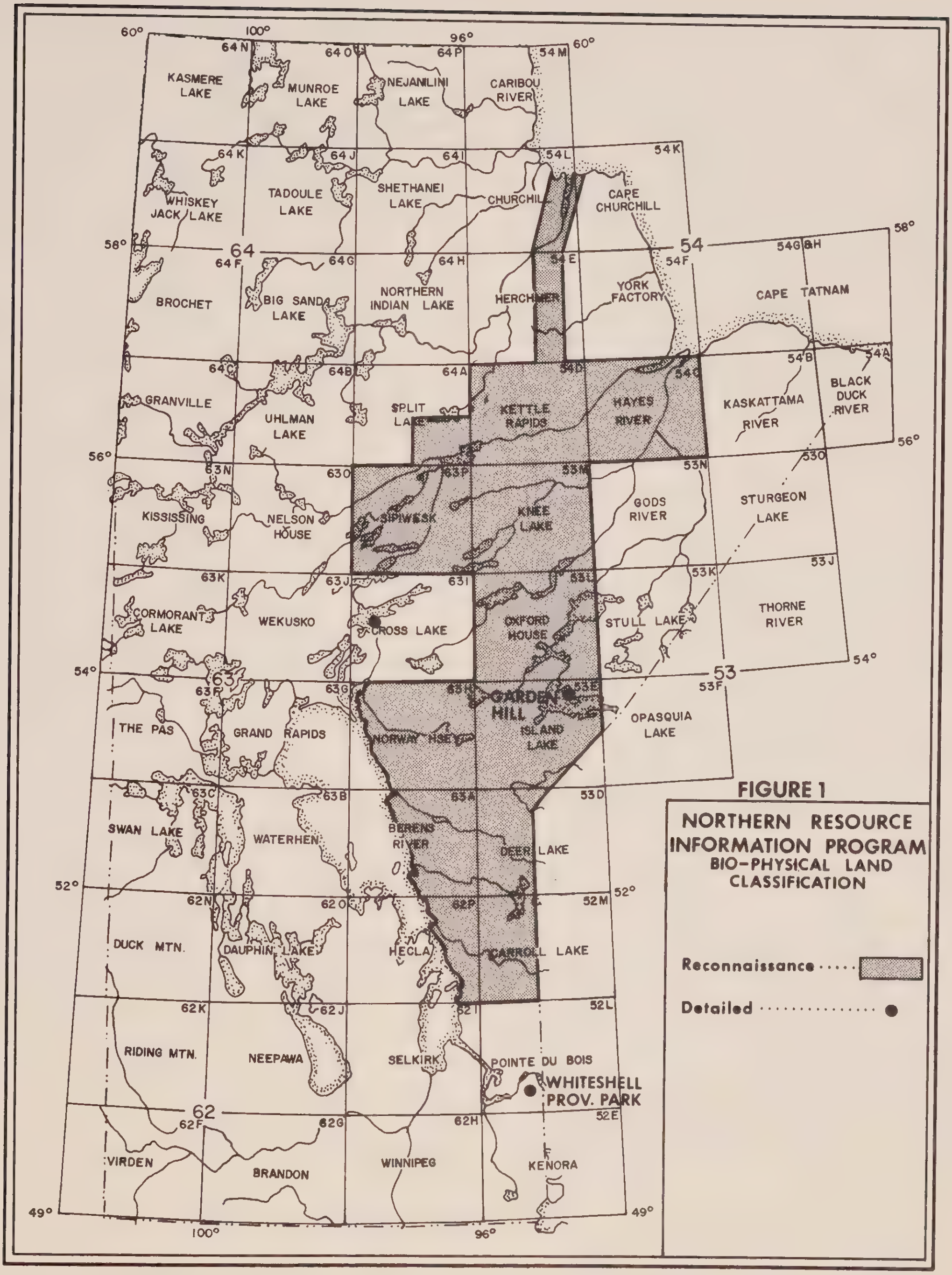


Figure 1: Location of Ecological Land Classification Surveys in Manitoba

consistent with recommendations based on the analysis.

A further example of application of an ecological land classification mapping program includes analysis for selection of recreation sites suitable for cottage development. Within the Whiteshell Provincial Park a number of potential lakes for cottage development were identified and criteria for determining suitability were given. On the basis of terrain analysis the team identified specific sites for development and provided an indication of carrying capacity. Also the team identified location of road access to the development sites. It should be noted, however, that the terrain analysis was only one of many inputs for this project. Others included present and potential economic use of resources, historical and cultural aspects of the native people, existing wildlife and implication for its use or protection, etc.

The merits of the approach adopted lie primarily in providing for an objective analysis in sufficient detail to provide for site specific planning through interpretation of the biophysical data. The base line information containing the same level of detail, generally includes a description of the same features, viz. surficial deposits, soil, topography, vegetation, drainage, etc. Report and map formats are similar and map scale is standard. The approach lends itself to immediate response and when a high priority project develops with limited lead time the terrain analysis team can respond immediately and a fairly comprehensive report can be prepared within a matter of weeks.

The approach taken nevertheless, does present a number of problems. The program responds to specific requests and although ecological (biophysical) analysis is comprehensive, the interpretations relate directly to what is required at the time rather than to all inclusive potential future requirements. It is conceivable therefore, that within a short period of time additional interpretations may have to be made, but, it is expected the basic ecological data will be complete and interpretations can be made without further field work. Another problem lies in the area of user expertise and experience in using ecological land classification information. It is expected that on some occasions staff may be responding to the needs of an engineer with training and experience in land use planning whereas in other cases staff may be responding to a request from members of a community council with no training in handling the information presented. To overcome this problem interpretations are provided in what could be considered layman's language. In its simplest form the interpretations for capability are stated as *high*, *medium* or *low*. More technical information is presented in a separate section towards the end of the report. Thus the layman can follow the report as far as his competence allows whereas the professional may wish to use only the technical data. In those cases where the user has limited or no training or experience it is expected trained expertise will work with the user to provide assistance.

Another problem that has emerged is to determine the degree to which interpretations should be made and included in the report. The team working on the analysis is proficient in air photo interpretation and standard ecological (biophysical) analysis. The team, however, is expected to make interpretations for various uses e.g., agriculture, recreation, residential, etc.; interpretations that require the input of expertise from a variety of disciplines. This problem is being overcome by having discipline expertise provide criteria to which the ecological (biophysical) data is applied to make the necessary interpretation. Also the interpretation may imply certain management techniques that consider the sensitivity of the environment e.g. certain forestry practices may be recommended, but the professional forester may prefer to develop his own management practices based upon his own expertise as applied to the ecological land classification.

SUMMARY

At this point in time, Manitoba's experience in application of ecological land information derived from the integrated methodology common to current ecological land classifications is limited. Maps produced at reconnaissance scales have not been available to the user for sufficient time to fully evaluate their application. There is fair demand for the maps, but follow-up activity as to how they are being used has not been undertaken.

It should be pointed out that provincial planners and managers of land resources are not unaware of the benefits of utilizing ecological data concerning land. Soil survey data, as mentioned earlier, describes many ecological relationships about land, and has been utilized extensively in the province at both reconnaissance and detailed scales for some 50 years.

The more recent detailed presentation of community specific information has had extremely positive reaction from planners responsible for site specific land use plan development for communities. It is expected that applica-

tion of integrated ecological land data in this area will increase substantially.

REFERENCES

Borys, A.E. 1976. Present Status of Biophysical Activities in Manitoba. pp 31-32 *in* Proc. 1st Meeting Can. Comm. Ecol. Land. Classif. (comp. and ed. by J. Thie and G. Ironside).Ecol. Land Classif. Series No.1, Lands Directorate, Environment Canada, Ottawa. 269 p.

Christian, C.S. 1958. The concepts of land units and land systems. Proc. 9th Pacific Science Congress 1957, Vol. 20: 74-81.

Hills, G.A. 1960. Regional Site Research. Forestry Chronicle 36: 401-423.

Mills, G.F. 1976. Biophysical Land Classification of Northern Manitoba. pp 201-219 *in* Proc. 1st Meeting Can. Comm. Ecol. Land Classif. (comp. and ed. by J. Thie and G. Ironside).Ecol. Land Classif. Series No.1, Lands Directorate, Environment Canada, Ottawa, 269 p.

Subcommittee on Biophysical Land Classification (SBLC). 1969. Guidelines for biophysical land classification. (comp. and ed. by D.S. Lacate). Can. For. Ser. Publ. No. 1264. 61 p.

Zoltai, S.C., E.T. Oswald, and C. Tarnocai. 1969. Land classification for land evaluation: Cormorant Lake Pilot Project, Forest Research Laboratory, Winnipeg, Man., Information Report MS-X-20, Dept. of Fisheries and Forestry, 31 p. and maps.

ABSTRACT

Manitoba has long been involved in collecting land resource data by means of such single discipline surveys as soils, forest cover, wildlife, groundwater, etc. In 1974, a separate program based on the generally accepted principles of ecological (biophysical) land classification was developed to focus on the boreal region of northern Manitoba. The area classified was ground truthed at a broad reconnaissance level and ecological data was presented on a land system map at a scale of 1:125,000. In total, approximately 93,383 km^2 within 9¼ NTS map sheets were mapped.

In 1977, the program was modified with emphasis redirected from reconnaissance toward meeting predetermined information needs for site specific land use planning and included description of the ecological characteristics as well as interpretations for certain capabilities. Information was related to the land type level and was presented on 1:6000 scale maps. The detailed mapping will have more immediate applicability to the planning process.

RÉSUMÉ

Le Manitoba a longtemps fait des relevés de ses ressources foncières au moyen d'étude unidisciplinaires qui portaient sur les sols, le couvert forestier, la faune, l'eau de fond, etc. En 1974, on a mis sur pied un programme nouveau fondé sur les principes généralement acceptés de la classification écologique (biophysique) du territoire pour la région du Manitoba Nord. Des vérifications au sol ont été effectuées dans la région classifiée (degré superficiel de reconnaissance) et les données écologiques recueillies ont été reproduites sur une carte des systèmes écologiques à l'échelle de 1:125,000. En tout, environ de 93,383 km^2 sont couverts par 9¼ cartes de SNRC.

En 1977, on a modifié le programme, axé antérieurement sur la reconnaissance, en vue d'obtenir des informations nécessaires à la planification de l'utilisation des terres dans certains secteurs précis. On a fait une description et une interprétation des caractéristiques écologiques en fonction de certaines possibilités d'exploitation. Les données, cartographiées à l'échelle de 1:6000, portaient sur les types écologiques. Ces cartes détaillées seront d'application plus directe pour les travaux de planification.
(Trad. Éd.)

RECENT ECOLOGICAL LAND CLASSIFICATION ACTIVITIES IN NEWFOUNDLAND*

B. B. Delaney
Dept. of Forestry and Agriculture
St. John's, Newfoundland

Since the last meeting of the CCELC in Petawawa in 1976 a number of land classification projects utilizing biophysical principles have been completed. These include several land inventories for impact assessment of hydro developments, for planning in national parks and a reconnaissance study of Labrador in 1977. Most recently a substantial commitment has been made to carry out detailed forest site mapping as the planning base for intensive forest management.

The full impact of the energy crisis is evident in this province where there is a large dependency on imported oil for generating electricity. This has created a need to evaluate all rivers for hydro development potential to reduce this dependency. Newfoundland and Labrador Hydro Corporation has conducted ecological studies of several rivers to provide the base data in order to carry out environmental impact studies. The following are some of the studies either underway or completed (Figure 1).

1. Cat Arm River
2. Upper Salmon River
3. Hinds Lake
4. Lower Churchill River (Gull Island)

This work has been conducted mainly by consulting firms. The continued commitment of Newfoundland and Labrador Hydro to use ecological land classification techniques as a preliminary step in assessing the impact of proposed developments, indicates an important application of ecological data. Ecological land inventories have also been conducted as part of the assessment study of a uranium development site in Labrador.

Ecological surveys have been recently completed for the Gros Morne and Terra Nova National Parks and for the L'Anse au Meadow Historic Site. Parks Canada will use the information as a basis for planning future park development. In addition, present park activities can be evaluated in an attempt to identify possible future problems. The Provincial Parks Service also recognized the usefulness of this base line data; however manpower and financial limitations have precluded implementation of a program.

During 1976 the Lands Directorate (Atlantic Region), in collaboration with Provincial Department of Forestry and Agriculture, carried out a reconnaissance ecological land classification of Labrador. This work involved the mapping of land regions and land districts at the 1:1,000,000 utilizing visual interpretive information obtained from LANDSAT imagery. During 1978 a two year project is expected to begin mapping priority areas of Labrador at greater levels of detail. This work will be a continuation of the preliminary work of the Lands Directorate and the Lands Branch of the Department of Forestry and Agriculture.

Recently in Newfoundland, forest improvement programs have been expanded and the situation will be intensified when a new provincial tree nursery becomes fully operational in 1981. This transition from an unmanaged forest will require a much better understanding of the forest land. The decision to commit silviculture funds for long periods of time should only be taken following long term resource planning. The Department of Forestry and Agriculture has initiated a forest site mapping program, using ecological land classification procedures, which will provide the data base for intensive forest management. This program is carried out in conjunction with the forest inventory program. Information will be presented at several levels of detail and will compare with the land system and land type units commonly in use. The lowest level of mapping detail will be at a scale of 1:12,500 and will be carried out for only the most productive sites in the management unit.

* Abstract/Résumé on/à page 81.

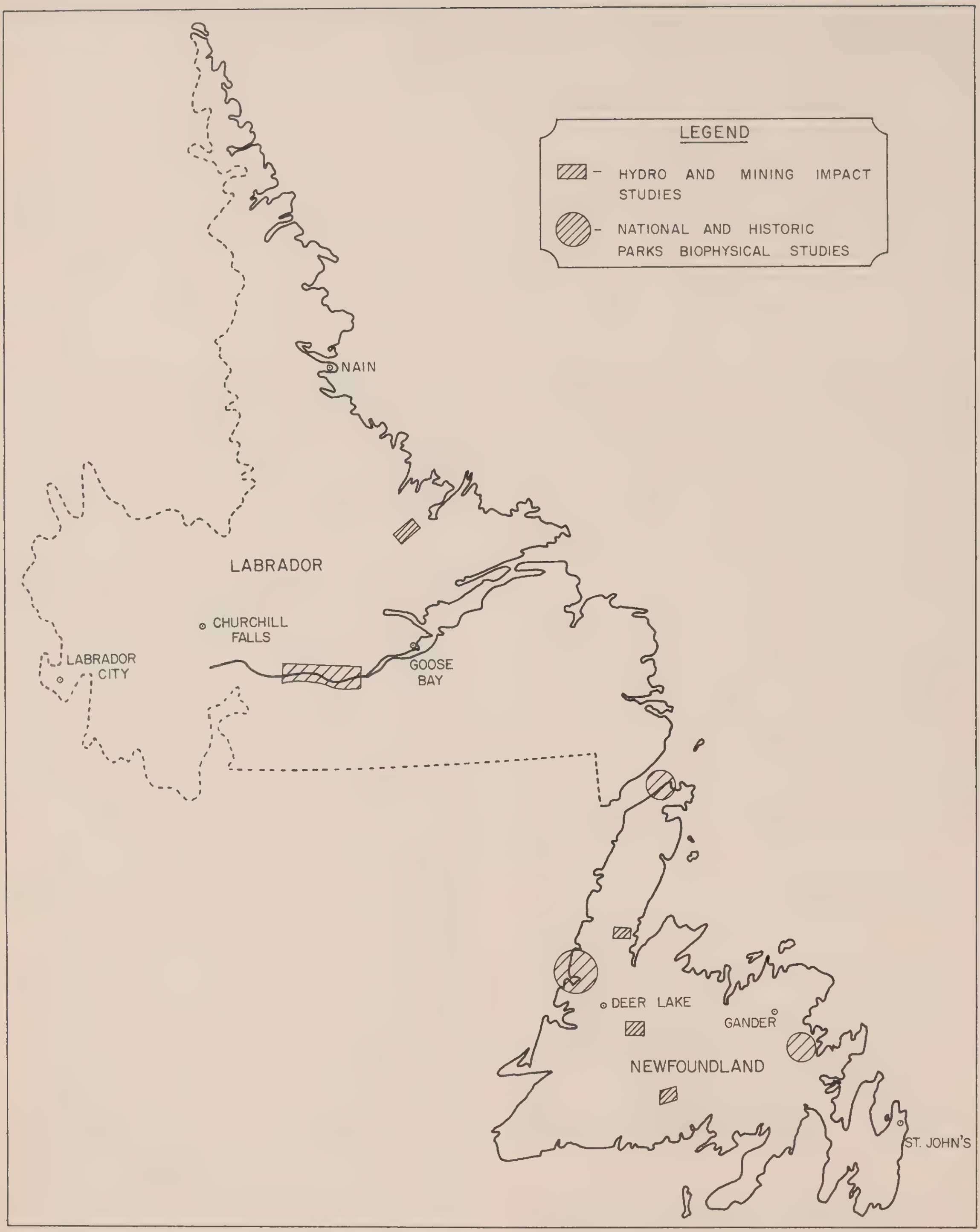


Figure 1: Areas Recently Covered by Ecological Land Surveys in Newfoundland and Labrador

This is the same scale as forest cover type maps of the inventory and as such is ideally suited for operational planning. This work is underway for two complete forest management units and will provide the data base for recognizing sites for intensive management, the status of present forest (mature and cutover areas), and prescriptions for silviculture programs. The first forest management unit should be completed in approximately one year and will serve as a test case for ecological classification to use in operational planning for a managed forest. While many of the methods and information presentations are not completely formulated, in another year this project should be well underway.

Just recently a project was approved for an inventory of peatland in a substantial portion of Newfoundland. The objective is to determine the quality and quantity of peatlands and potential uses (peat moss, agriculture, fuel and forestry). The classification developed and proposed by the Wetlands Classification Working Group of the CCELC will be used in this study. Although the inventory has presently a one year commitment it can be expected that further work will be carried out.

In summary, there is a general recognition today of the merits of ecological land classification by various users in many disciplines in this Province. Current inventory work employs methods which seek to identify physical and biological processes which shape the environment. These contribute to a better understanding of the land and water resources revealing that studies initiated by one discipline are of value to all resource planners.

ABSTRACT

There is wide acceptance of the concepts and procedures of ecological land classification procedures in Newfoundland. This stems from the Canada Land Inventory program and biophysical projects carried out in the late 60's and early 70's. In recent years, there has not been any elaborate or systematic land classification program underway. Instead, there have been many individual projects initiated for specific purposes. There is some indication that with new initiatives in forest management, ecological land classification will be a prerequisite in planning silvicultural programs. (Ed. Abstr.)

RÉSUMÉ

Les principes et procédures de la classification écologique des terres à Terres-Neuve sont généralement acceptés. Cette attitude découle des programmes relatifs à l'Inventaire des Terres du Canada et des projets pilotes en biophysique effectués à la fin des années 60 et au début des années 70. Aucun programme élaboré ou systématique du genre n'a été exécuté au cours des dernières années. Ont plutôt pris naissance de nombreux projets individuels à des fins précises. Certains indices laissent présager que de nouvelles initiatives dans le domaine de la gestion des forêts rendra la classification écologique des terres indispensable à la planification des programmes de sylviculture. (Rés. Éd.)

ECOLOGICAL (BIOPHYSICAL) LAND CLASSIFICATION ACTIVITIES IN ALBERTA

J. R. Prokopchuk and P. M. Ojamaa
Resource Evaluation and Planning Division
Alberta Energy and Natural Resources
Edmonton, Alberta

ABSTRACT

The current status of ecological (biophysical) land classification (ELC)projects in Alberta is outlined for each of the federal and provincial agencies involved. The contribution of the ELC approach to ecological awareness and planning in Alberta is varied and stimulating but still remains on an initial plane. (Ed. Abstr.)

RÉSUMÉ

L'auteur décrit l'état actuel des projets de classification écologique (biophysique) des terres (CET) en Alberta pour chacun des organismes fédéraux et provinciaux concernés. L'application des méthodes de la CET à la sensibilisation et la planification écologiques en Alberta est diversifiée et stimulatrice, mais demeure encore au plan initial. (Rés. Éd.)

INTRODUCTION

The awareness, appreciation and use of the ecological (biophysical) land classification (ELC) approach to landscape data collection is growing in Alberta. The on-going Federal ELC project in Banff and Jasper National Parks (Holland, 1976) and the cooperative Federal-Provincial project involving biogeoclimatic classification (Kojima and Krumlik, 1977) are reasonably well known. Provincial activitiy in ELC type studies is accelerating and significant additional experience has been attained since the report of Rennick (1976).

AGENCY INVOLVEMENT

The various Federal and Provincial Governmental agencies presently active in ELC or ELC-type projects are listed below:

1) Canadian Forestry Service in cooperation with the Alberta Institute of Pedology, Canadian Wildlife Service, Atmospheric Environment Service and Parks Canada.
2) Alberta Forest Service in cooperation with the Canadian Forestry Service.
3) Alberta Environment, specifically through the Alberta Oil Sands Environmental Research Project (AOSERP) and the Planning Division.
4) Alberta Recreation, Parks, and Wildlife, dominantly through the Provincial Parks Division.
5) Alberta Transportation, specifically the Strategic Planning Branch.
6) Alberta Energy and Natural Resources dominantly through the Resource Inventory and Appraisal Section of the Resource Evaluation and Planning Division, and
7) Consulting firms outside of government.

REVIEW OF ACTIVITIES

The following is a brief expansion on the nature of the project(s) undertaken by the agencies listed above.

Canadian Forestry Service

Since 1974 the Canadian Forestry Service, in cooperation with various other agencies, has been conducting an ecological land classification in Banff and Jasper National Parks (Holland, 1976). Much success has been achieved by the project and, of late, integration of the wildlife component is underway. It is expected that the parks will be completed at the scale of 1:50,000 by 1981 (Holland, pers. comm.). The knowledge gained from the ELC project will be used for a myriad of programs and problems revolving around the management of these key mountain National Parks (Holland et al, 1975).

Alberta Forest Service

In 1976 agreement was reached between the Alberta Forest Service and Canadian Forestry Service to allow the latter to develop a biogeoclimatic ecosystem classification of the forests of Alberta (Kojima, 1977). The system basically attempts to follow the conceptual approach developed by V.J. Krajina of the University of British Columbia. Fieldwork in 1977 and 1978 concentrated in northeast and northwest Alberta. Eventual output will involve maps at the following scales: 1:1,000,000 depicting biogeoclimatic zones, 1:250,000 displaying biogeo-

climatic subzones, and 1:10,000 detailing portions of homogeneous ecosystem units from plant associations ascertained taxonomically 'from below'. Data gained will be applied to forest management problems varying from logging methods to choice of species for specific sites, erosion hazard, silvicultural methods and choice of forest recreation sites.

Alberta Environment

Alberta environment through their AOSERP agency is undertaking the collection of land and aquatic based ecological data. The program is in its beginning stages with contracts for data collection given to private consulting firms. The area of concern centers around a 29,800 km^2 block near Fort McMurray. The land habitat portion will produce a reconnaissance inventory of 1:50,000 maps accompanied with ELC description on vegetation, landforms, soil, etc., by late 1978. Involved is the identification of habitat for wildlife and elucidation of successional and/or dynamic trends in the landscape. The data will assist in the formulation of reclamation procedures for the tarsands area and in the inference of air pollution levels based on departures from known vegetation trends. The aquatic habitat portion plans to coordinate with the land portion in developing a methodology to enable the water quality of the study area to be monitored and assessed so as to pinpoint departures in water quality from baseline data.

The Planning Division of Alberta Environment is involved with river basin planning throughout the Province of Alberta. Specifically there is one planner per major basin with primary concern for the water resource. Much of their program involves the land-water interface where a team approach is utilized to assess the hydrology, water quality, water quantity, and fish and wildlife concerns. Inhouse capability for ecological studies is available but private consulting firms are also utilized. Applications include flood hazard mapping, water quality monitoring, and floodplain and shoreline zoning.

Alberta Recreation, Parks and Wildlife

The Provincial Parks Division of Alberta Recreation, Parks and Wildlife through their system of Provincial Parks and their involvement in the survey for and assistance in the selection of *Ecological Reserves* has a strong ecological consciousness. Their involvement entails descriptions of the natural ecosystems occurring within Provincial Parks. The assessment of areas suitable for Ecological Reserves involves a refinement of Rowe's (1972) forest zonation of Alberta. It is intended that, via a team approach, suitable areas representing the full range of the natural environmental diversity of Alberta will be identified as part of a conservation/preservation system.

The identification, though based on vegetation types, recognizes the need for concomitant physiographic, climatic, and pedologic inventories. Applications of the eventual inventory data are seen in steering development in Parks away from sensitive areas; zoning; suitability estimation for recreation; and preservation.

Alberta Transportation

Alberta Transportation, through their Strategic Planning Branch, has utillized a very interesting and potentially powerful methodology involving separate ecological and socioeconomic inputs. The inputs are assessed for potential interactions between the subjects and the various aspects of highway development with the interactions weighted and arrayed either in matrix form for visual analysis or digitized for computer analysis. In one study, the thorough computer analysis derived a *capability composite map* by which highway route alternatives could be confidently evaluated. Given proper weighting procedures, the development of computer based data handling allows for relatively fast and complete analysis of large masses of multivariate ecologic data. When combined with economic, social, and other data, intelligent highway corridor selection is significantly enhanced.

Alberta Energy and Natural Resources

ELC and ELC-type analyses play an integral role in the functions of the Resource Inventory and Appraisal Section of Alberta Energy and Natural Resources. The Section is responsible for the acquisition, analysis, assessment, and coordination of inventory data for all renewable and non-renewable resources. Within the Section there are three groups: Land Classification, Resource Inventory, and Resource Appraisal.

The Land Classification Group is presently involved in the following projects:

a) *Alberta Land Inventory (ALI)* As a continuation of CLI forest capability mapping the ALI was established primarily to complete those areas of the Province not mapped by CLI. The Land Classification Group provides the interpretation and mapping of geomorphic features of the landscape which is a prerequisite to forest capability rating. Data are

provided on 1:63,360 as well as complexed 1:250,000 scale maps.
b) *Land Analysis Program:* This program involves the analysis and map presentation of inherent properties of the physical landscape based on its variable composition, morphology, and pedological characteristics. Data are acquired from various scales of aerial photography. The proposed methodology is conceptually based on the landform classification of the *Canadian System of Soil Classification* (Canada Soil Survey Committee, 1978) and has much relationship with biophysical guidelines (Subcommittee on Biophysical Land Classification, 1969) and terrain classification systems (Environment and Land Use Secretariat, 1976).

The Resource Inventory Group is involved in the following programs:
a) *Forest Inventory (Phase III):* Modified infrared aerial photography at 1:15,000 scale is utilized to provide a comprehensive forest cover inventory with map output at the same scale. Map production for the balance of the program will be 65,000 km^2/year.
b) *Forest Site Capability Program:* Projected as a follow-up to the ALI, this program would yield data of a more site-specific nature tailored to ELC guidelines.
c) *Forage Inventory:* Designed to meet the need for forage and browse data, this recent program attempts to assess ground cover resources and their relationship to both domestic grazing and ungulate carrying capacity. Map output at 1:50,000 scale will display terrain data from the Land Classification Group, forest cover, and estimates of biomass and animal carrying capacity.

The Resource appraisal Group has a long history of utilizing ELC techniques in its role of providing technical data suitable for direct input into land use planning (for pre-1976 methodology see Rennick, 1976). The Group embraces the general tenets of ELC philosophy/methodology outlined by Rowe (1979). The Group collects ELC data at various scales, depending on planning problem and photo availability. To date, over 40 reports have been produced which cover an average area of 2600 km^2 with accompanying map output at 1:125,000 to 1:100,000. A trend to more large-scale land type projects (Luff and Ojamaa, 1979) is expected. A recent change of approach has led to increasing utilization of interpretive use-limitation tables as a means of highlighting certain limitations and suitabilities of various land systems or land types for particular land uses. In the past year, the ELC output of the Resource Appraisal Group has been directly applied to large scale studies for the development of provincial grazing reserves, recreation planning, and parks planning along with smaller scale integrated management planning.

Consulting Firms

Several private consulting firms are engaged in ELC-type analysis. Projects vary from right-of-way to land classification.

SUMMARY

The foregoing is a brief summary outline of ELC and ELC-type activity in Alberta. The level of activity is high and the number of applications varied and stimulating. It suffices to say that the appreciation of this rapidly evolving applied resource field that we call ecological land classification is growing in Alberta. ELC's potential contribution toward better eclogical awareness and planning is just beginning.

REFERENCES

Canadian Soil Survey Committee. 1978. The Canadian System of Soil Classification. Agriculture Canada Publication No. 1646. 164 p.

Environment and Land Use Committee Secretariat. 1976. Terrain Classificatin System. British Columbia Ministry of Environment, Victoria, B.C.

Holland, W.D., B.D. Walker, S. Kojima, D.T. Allen and J. Dyck. 1975. Banff-Jasper Biophysical Land Inventory, Progress Report No. 1, 1974 - 75. Northern Forest Research Centre, Canadian Forestry Service, Edmonton, Alberta.

Holland, W.D. 1976. Biophysical Land Classification of Banff and Jasper National Parks, *in* Proc. First Meeting of Can. Comm. Ecol. Land Classif., Petawawa, Ont. Ecological Land Classification Series, No. 1, Lands Directorate, Environment Canada, Ottawa. pp. 221-237.

Kojima, S. 1977. Biogeoclimatic Ecosystem Classification of Alberta: Philosophy, Objective, Methodology, and Benefits. Northern Forest Research Centre, Can. For. Ser., Edmonton, Alberta.

Kojima, S. and G.J. Krumlik. 1977. Ecological Classification of Forests in Alberta, *in* Proc. Symposium on Ecological Classification of Forest Land in Canada and Northwestern U.S.A., Vancouver, B.C. pp. 199-207.

Luff, D. and P.M. Ojamaa. 1979. The Value of Ecological Land Classification in Land Use Planning *in* Proc. Second Meeting of the Can. Comm. Ecol. Land Classif. Victoria, B.C. (paper in these proceedings).

Rennick, P.H., 1976. The Use of Biophysical Analysis in Land Use Planning, *in* Proc. First Meeting of the Can. Comm. Ecol. Land Classif. Petawawa, Ont. Ecological Land Classification Series, No. 1, Lands Directorate Environment Canada, Ottawa, pp. 245-255.

Rowe. J.S. 1972. Forest Regions of Canada, Can. For. Ser. Publ. No. 1300, Ottawa.

Rowe, J.S. 1979. Methodology, Philosophy Working Paper *in* Proc. 2nd Meeting, Can. Comm. Ecol. Land. Classif. Victoria, B.C. (paper in these proceedings).

Subcommittee on Biophysical Land Classification. 1969. Guidelines for Biophysical Land Classification (ed. by D.S. Lacate). Can. For. Ser. Pub. No. 1264. Ottawa.

CURRENT LAND CLASSIFICATION ACTIVITIES IN NOVA SCOTIA AND NEW BRUNSWICK

C. D. Rubec
CCELC Secretariat
Ottawa, Ontario

ABSTRACT

A brief summary of current land classification and management activities in the provinces of New Brunswick and Nova Scotia is outlined. Both provinces continue to concentrate on timber operations, fish and wildlife development and recreation enhancement in land classification applications.

RÉSUMÉ

L'auteur résume brièvement les activités de classification et de gestion des terres dans les provinces du Nouveau-Brunswick et de la Nouvelle-Écosse. Ces dernières continuent de mettre l'accent sur les opérations forestières, la mise en valeur de la pêche et de la faune et l'augmentation des activités récréatives.

INTRODUCTION

While representatives from the provinces of Nova Scotia and New Brunswick were not able to attend the second meeting of the Canada Committee on Ecological Land Classification, brief summaries of current activities were received by the CCELC Secretariat; the contents of which are outlined in this paper. Summaries were received from Mr. E.T. Owens, Deputy Minister of the New Brunswick Department of Natural Resources and from Mr. R.M. Bulmer, Director of Forest Planning, Nova Scotia Department of Lands and Forests.

NOVA SCOTIA

The Nova Scotia Department of Lands and Forests continues a program for ecological management on prescriptions on provincial crown lands as previously outlined by Bailey and MacAulay (1976). The objective of this program is to assign ecologically sound forest stand management prescriptions to blocks of provincial crown lands which qualify for financial assistance under the federal - provincial General Development Agreement (GDA).

To achieve this objective, managemnent units eligible for GDA assistance are stereoscopically divided into land systems, mainly on the basis of soils, topographic features, and vegetation. Each system is assigned a management priority by assessing forest capability; manageability as indicated by topography, vegetation, surficial conditions, etc.; and present as well as projected access. Land systems having a high management priority are subsequently subdivided into land-vegetation types based on: (a) soil depth, moisture and fertility, (b) vegetation, (c) topography, and (d) land capability. Each land-vegetation type is visted in the field and a management prescription assigned after consideration of the inter-relationships of the forest-soil-management input. The total number and type of land-vegetation units visited is dependent on the silvicultural and harvesting requirements of annual operating plans.

The major benefits for Nova Scotia accrue from proper forest management in terms of greater timber productivity and better fiscal and biological management. Staff limitations are the only constraints on such a program. Nova Scotia project leaders are Mr. Ed Bailey and Mr. Ed MacAulay, Department of Lands and Forests, Box 68, Truro, Nova Scotia, B2N 5B8.

NEW BRUNSWICK

The Province of New Brunswick has been engaged in land classification for timber management on provincial crown lands for many years. The objectives of this program have been to prepare and implement forest resources management plans for crown lands to include: (a) consideration of fish and wildlife habitat, (b) stream protection, (c) lake protection, (d) recreation values, as well as (e) access, (f) harvesting schedules, (g) harvest area and location, and (h) regeneration requirements.

Crown land planning in New Brunswick includes specific applications of land classification to annual timber harvesting operations through permits, fish, wildlife and recreational development. The program encourages continued economic benefit from the timber resource as well as general environmental protection. In this province, the essential component is successful and effective application to site-specific problems. The overall project involves headquarters and field staff of the New Brunswick Department of Natural Resources, Box 6000, Frederiction, N.B., E3B 5H1.

STATUS OF ECOLOGICAL LAND CLASSIFICATION IN MARITIME CANADA

No major ecological land classification (ELC) projects have been undertaken in New Brunswick or Nova Scotia. Weetman (1977) has reviewed the background to current recommendations in both of these provinces that an ELC approach be adopted for land management here. Although the level of forest management has intensified rapidly, institutional mechanisms, policy, and financing have not been, to date, appropriate for detailed large-scale ecological land classification. Weetman stressed the need for closer cooperation between soil surveyors and ecological mappers in these Maritime provinces.

REFERENCES

Bailey, R.E. and E.M. MacAulay. 1976. Biophysical classification in Nova Scotia. *in* Proc. First Meeting Can. Comm. Ecol. Land. Classif. Ecological Land Classification Series No. 1. Lands Directorate, Environment Canada, Ottawa. pp. 39-44.

Weetman, G.F. 1977. Ecological Land Classification in New Brunswick and Nova Scotia: A Status Report. *in* Proc. Sym. on Ecological Classification of Forest Land in Canada and Northwestern U.S.A. September 30-October 2, 1977. Vancouver B.C. pp.265-273.

REPORTS BY REPRESENTATIVES OF FEDERAL AGENCIES

RAPPORTS DES REPRÉSENTANTS DES AGENCES FÉDÉRALES

THE APPLICATION OF ECOLOGICAL LAND CLASSIFICATION TO ENVIRONMENTAL IMPACT ASSESSMENT

P. J. B. Duffy
Federal Environmental Assessment
Review Office
Environment Canada
Ottawa, Ontario

ABSTRACT

The use of ecological land classification in the environmental impact assessment of Canadian projects is described. Examples are drawn from projects in Newfoundland, Nova Scotia, Quebec, Alberta and the Northwest Territories. Applications of ELC have been limited. However they confirm the potential usefulness of the system as an organized, efficient, and cost-effective approach to baseline information gathering for this purpose. The flexibility of map scale and report detail of ELC lends itself to the assembly of generalized information at the early stages of the environmental impact assessment process. As more detail is required on specific sites (e.g. pipeline river crossings) and ecologically sensitive areas (e.g. caribou calving grounds) then larger scale maps and more detailed baseline information can be added within an existing ELC framework.

RÉSUMÉ

L'auteur traite de l'application de la classification écologique des terres (CET) aux méthodes d'évaluation des répercussions sur l'environnement de projets réalisés au Canada. Des exemples sont tirés de projets exécutés dans les provinces de Terre-Neuve, Nouvelle-Écosse, Québec, Alberta et dans less Territoires du Nord-Ouest. Les applications de cette classification ont été limitées. Elles démontrent toutefois l'utilité éventuelle du système en tant que méthode systématique, efficace et rentable de collecte de données de base à cette fin. La flexibilité de l'échelle des cartes et des éléments des rapports de la CET se prête à l'assemblage d'information généralisée dès les premières étapes du processus d'évaluation. À mesure que des précisions se révèlent nécessaires sur des endroits particuliers (par exemple la construction d'un pipeline à travers un cours d'eau) et des environnements fragiles (par exemple les terrains de mise bas des caribous), des cartes à plus grande échelle et des données de base plus détaillées peuvent alors être ajoutées à l'interieur du cadre de la CET. (Trad. Éd.)

INTRODUCTION

Environmental impact assessment activity has been carried out in a formal sense in Canada for about 7 years. Soon after the introduction of the National Environment Policy Act in the U.S.A. (1970), the Canadian federal and provincial governments instituted environmental impact assessment processes to insure that the environmental effects of major projects and operations are given consideration before the decision is taken to proceed with the project or operation. Up to the present time each of the provincial governments in Canada, and the federal government have embarked on programs of environmental impact assessment (B.C. Ministry of the Environment, 1977).

Some of these programs provide for the assessment of major government decisions on policies, operations, and physical projects. However, up to the present completed environmental impact studies have dealt only with the latter category i.e. major physical projects. In the future the environmental assessment of major operations such as fertilization of agricultural land, agricultural and forest pest spraying, and new management programs for fish stocks may also be carried out.

Depending on the provincial or federal government programs, some or all of the following phases are included in the process:

1) screening of proposed projects for potential adverse environmental impacts;

2) initial environmental evaluation;

3) detailed environmental impact assessment;

4) cabinet level decision making on major processes.

Baseline information is employed for project planning and feasibility, initial screening of projects, impact studies, and impact assessment. It is also necessary for the review process undertaken by commissions, panels, or other review bodies.

Each phase of the process of environmental impact assessment is highly dependent on an adequate environmental and natural resource data base. In this paper this data base is referred to as baseline information which may be defined as a description of environmental properties and processes within a specifically defined area taking into account the dynamic and interactive nature of ecosystems, which will allow the identification of possible environmental impacts resulting from any anticipated intrusion by man within a specified time frame to meet the requirements of environmental impact assessment. Experience has shown that major gaps in baseline information often lead to costly delays in project planning and commissioning, overly conservative mitigation measures, costly compensation for unavoidable losses of environmental quality or habitat, and in some cases, deferral or cancellation of the project.

Characteristically, projects which come up for environmental impact assessment have some or all from the following features, which have a bearing on baseline information gathering:

1) projects are large and complex and cause impacts on different parts of the environment. Some projects such as airports have some major features in common. However, projects reviewed up to the present do differ sufficiently, one from the other, to require project-specific baseline information, data assembly and impact assessment.

2) projects are often in remote areas for which comprehensive baseline information is unavailable in the initial planning phases.

3) some projects are planned for urban or suburban locations with attendant socioeconomic problems and high political profiles.

4) high capital costs and, in some cases, high operating costs.

5) certain projects are very large and require detailed attention to ecologically and socially sensitive locations such as river crossings, routing through populated areas and highly productive lands.

6) certain projects bring problems of substantial complexity such as construction in permafrost, and climate effects such as icing on transmission lines.

7) some projects are planned, reviewed and commissioned within tight time frames.

Because of these characteristics, the environmental planning and the development of major projects in the past 10-15 years has had the effect of redirecting a large portion of government funded baseline information surveys in Canada. Project priorities have caused survey organizations to react promptly to the demands for geotechnical, vegetation, socioeconomic and other information for new project locations and corridors. This has had the effect of disrupting survey program schedules of a traditional nature.

Where natural resource and environmental surveys have already been undertaken prior to feasibility planning for major projects, it has been necessary in some cases, to mount accelerated baseline information programs to assemble the necessary additional data to plan the projects and assess environmental effects. Recently there have been some arrangements made for cost-sharing of baseline information surveys required to meet accelerated schedules. Cost-sharing may require the industrial proponent or developer to share the costs of the accelerated portion of the baseline information program. For instance the federal policy on this has been described as follows:

"The federal government accepts the financial responsibility for environmental baseline studies, while the cost of preparing environmental evaluation reports is the responsibility of the proponent. The government and the proponent share the cost of accelerated baseline studies, the incremental cost resulting from acceleration being charged to the proponent." (Hurtubise, 1977).

ECOLOGICAL LAND CLASSIFICATION (ELC)

Ecological land classification surveys are aimed at organized mapping and description of land units, with emphasis on geomorphology, soils, vegetation, and climate. These surveys are mainly for reconnaissance purposes and rely heavily on aerial photo interpretation and prescribed observations by small teams of research scientists with expertise in geomorphology, pedology, ecology and climatology. Interpretation of the survey data permits the description of present and potential land use and capability for such sectors as agriculture, forestry, recreation, range management, trafficability

and others.

The mapping unit for these reconnaissance surveys is the *land system* defined as 'an area of land throughout which there is a recurring pattern of landforms, soils, vegetation chronosequence and water bodies'. Land systems are usually mapped at a scale of 1:125,000. The component element of the land system is the *land type* defined as 'an area of land having a fairly homogeneous combination of soil (e.g. soil series) and chronosequence of vegetation'. Land types may be mapped at scales ranging from 1:10,000 - 1:20,000. In arid areas some land types may be mapped at scales of 1:30,000 - 1:60,000. The Canadian Ecological Land Classification System provides for smaller units to be mapped (*land phases* at a scale of 1:10,000 or larger). At the other end of the scale, *land districts* (1:500,000 - 1:1,000,000) and *land regions* (1:1,000,000 and 1:3,000,000) provide for more generalized land resource maps which are sometimes derived from high altitude and satellite imagery. These ELC units are tabulated and defined in Table 1.

TABLE 1

Levels of generalization Common scales of mapping	Current definitions
Land region 1 : 1,000,000 to 1 : 3,000,000	An area of land characterized by a distinctive regional climate, as expressed by vegetation
Land district 1 : 500,000 to 1 : 1,000,000	An area of land characterized by a distinctive pattern of relief, geology, geomorphology
Land system 1 : 125,000 to 1 : 250,000	An area of land through which there is a recurring pattern of landforms, soils, vegetation chronosequences and water bodies.
Land type 1 : 10,000 to 1 : 20,000	An area of land having a fairly homogeneous combination of soil (e.g. soil series) and chronosequence of vegetation
Land phase 1 : 10,000 and greater	An area of land having a fairly homogeneous combination of soil and vegetation. Subdivision of *land type* based on vegetation succession as expressed by the existing vegetation at the time of the survey

Table 1: Ecological Land Classification Units in Use in Canada (Canada Committee on Ecological (Biophysical) Land Classification, 1977).

Ecological Land Classification is a baseline information gathering method with a set of features which distinguish it from other types of survey:

1) Multi-disciplinary teams of trained specialists.

2) Common reliance on aerial photo interpretation.

3) Concurrent surveys on several parts of the environment.

4) Short time frame relative to other types of surveys.

Ecological and related natural resource surveys have evolved in a trend from separated sector surveys of geology, soils, vegetation, and climate (1950's), to concurrent surveys of different sectors in the same survey area (1960's), to surveys of common land units by specialists in geology, soils, vegetation, and climate with integration of the baseline information taking place in the office *after* the field season (1970's), to some recent surveys which integrate the inputs of the different disciplines in the field. The latter stage represents a relatively high degree of sophistication in survey methodology, data analysis, and reporting of results. It most closely approaches the method and philosophy described in the biophysical guidelines (Subcommittee on Biophysical Land Classification, 1969). Developments in ELC in Canada since 1969 are outlined by Wiken and Ironside (1977).

These types of surveys have been variously referred to as ecological surveys, and without commenting on the degree of integration achieved, this paper will address the application of these types of surveys to environmental impact assessment.

APPLICATIONS OF ELC IN ENVIRONMENTAL IMPACT ASSESSMENT

In early 1978 a survey was made of applications of ELC to environmental impact studies and assessments across Canada.* The following examples are to illustrate the application of different degrees of ELC to the study of major physical projects and associated environmental effects.

Newfoundland - Labrador

Newfoundland and Labrador Hydro is presently evaluating two hydro electric power development proposals on the Island of Newfoundland to meet part of the forecast demand for electricity prior to obtaining additional power from Labrador. The Cat Arm project studies on the northern peninsula employed aerial photo interpretation to obtain a terrestrial land classification in the baseline information gathering phase and the same approach was taken on the Upper Salmon project proposal on the south shore of Newfoundland. The concurrent studies were scheduled so as to permit a comparison of the two projects according to economic, social and environmental criteria. At the present time new ecological land classification studies are being carried out (land type level) for the Cat Arm project only. Similar studies have been commissioned for the Hinds Lake project on the Island of Newfoundland and for the Gull Island project in southern Labrador. These projects employ aerial photo interpretation in the classification of geology, surficial materials and vegetation to define and characterize separate environments for project planning and environmental impact assessment.

Wreck Cove Hydro Electric Project Cape Breton Island, Nova Scotia

The Wreck Cove project was designed to tap the potential of a lake and stream combination in the Cape Breton Highlands in order to provide up to 200 MW of peaking power from a generating station located near Wreck Cove, Cape Breton. In order for government agencies to carry out the assessment of environmental impacts described in the project, a rapid reconnaissance of land and water resources was undertaken using ecological land classification techniques. The reconnaissance combined geology, surficial materials, vegetation, water bodies, and climate. This information was used in the assessment and review process and formed a basis for part of the government review of the project.[1]

---

*This is not the user survey which is reported elsewhere in these proceedings, by C.D. Rubec.

[1] G. Beanlands, January 1978, personal communication.

Point Deroche Project Prince Edward Island

A biophysical study of soils and vegetation was carried out to provide the basis for interpretation by provincial planners and the general public of an area along the north shore of Prince Edward Island east of the Prince Edward Island National Park boundary. The study area (10.4 square km) covered lands around Deroche Pond.[2]

Ecological Land Classification in Québec

The integrated land resource surveys carried out by the Direction Régionales des Terres, Environment Canada in Quebec City is described by Jurdant and Gerardin (1977). These studies include the James Bay area, Saguenay-Lac St. Jean, Anticosti Island and a Domainal Forest in the Appalachians as well as 13 other smaller areas in southern Québec. Although these surveys have employed various methods, the Jurdant team has carried out major surveys characterized by the integration of data from different disciplines, in the field. That is, land units have been identified, mapped, and characterized from interpretation of aerial photography and from field studies. This integration has resulted in a general understanding of the land units and the major ecological processes which distinguish the land systems, particularly in the James Bay and Lac St. Jean areas.

The James Bay ELC studies have been used directly in the preparation of environmental impact studies and assessments carried out by Hydro Québec and by the James Bay Energy Corporation. These include the corridor study for the Grande Baleine complex for routes LG 2-GB 1, a study of management alternatives on LG 1, miles 23 to 44, and ecological maps which serve as a basis for management studies for reservoirs LG 2 and Opinaca and the different reservoirs for the La Grande complex.[3]

Hydro Québec is also utilizing the ecological land classification of the Lac St. Jean area for the evaluation of the hydro electric project for the Chamouchouane River and for an inventory of the north shore of the St. Lawrence River with emphasis on the Romaine River area. This inventory will serve for the environmental impact studies of the hydro-electric project on the Romaine River and for proposed studies of access to the project site.

In addition the Environmental Directorate of Hydro Québec is using the ELC data base to examine alternative access routes to the Grande Baleine complex. This is the first project at James Bay which employs the ELC material as an information base. Other Hydro Québec applications include the use of completed maps of wildlife capability for the planning of aerial surveys of wildlife for the winter of 1978. In the near future ELC data will be used to evaluate the impacts of the proposed Grande Baleine hydro electric project.[4]

Alberta

In Alberta, ecological land classification surveys of the Banff and Jasper National Parks have been described by Holland (1976). The survey work involves the integration of surficial materials data, landform mapping and vegetation data all with an aerial photo interpretation approach. Environmental impact assessments have been carried out by Parks Canada on camp ground extension studies and on reclamation projects, among others.

Northwest Territories

Land unit mapping in the Mackenzie Valley has been described by Zoltai (1976). The surveys were undertaken in such a way that integration in the field was not possible, due to time constraints and the size of the survey area. However, the baseline information which was developed from these surveys was of use to government in the environmental impact assessment of the Mackenzie Valley Pipeline Project.

British Columbia

In British Columbia the Ministry of the Environment undertakes ecological land classification projects in support of planning major undertakings such as the east Kootenay coal developments, the Northeast coal development, and regional planning in connection with major hydro-electric projects. The ecological surveys are carried out by sector and by teams of

---

[2] H. Hirvonen, February, 1978 personal communication.

[3] C. Fontaine, February, 1978, personal communication.

[4] G. Gagnon, February, 1978 personal communication.

specialists, some of whom have ecological mapping skills in more than one discipline. Surficial geology, vegetation, climate, wildlife, and other environmental features are mapped and the integration of the map and report takes place in the office following field surveys. Thus the process does not yield integrated maps of land systems and other land units, but provides a basis for interdisciplinary review of land resources and classification, zoning, and allocation matters. This report and map information serves as a basis for government assessment and review of major physical projects in British Columbia.[5]

POTENTIAL USE OF ELC IN THE ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

Up to the present time, it appears that there has been limited application of ELC to Environmental Impact Assessment (EIA). However the importance of organized and comprehensive baseline information to EIA seems to be encouraging a trend towards more use of ELC. It is seen from the foregoing that environmental impact assessment of major projects benefits from ELC data and maps. Categories of major projects which employ baseline information of this type include oil and gas exploration and production, linear facilities such as highways and pipelines, nuclear power generating stations, airports, port developments, and new towns. Projects for which the classification is not clearly applicable include rehabilitation projects in urban core areas, and the assessment of new aerial transportation modes such as the SST and STOL aircraft.

Major projects are reviewed for their impacts in somewhat different ways in Canada, depending upon the provincial or federal jurisdiction which applies. However, most review is carried out along the lines of an environmental impact assessment review and process which is described as follows. This process or model is not meant to describe any one particular Canadian system, but rather to illustrate, in general, how baseline environmental information needs change as the process develops. For more detailed information, the reader is referred to Munn (1975) and Hurtubise (1977) from which the following description has been mainly derived.

The environmental impact assessment and review process involves many agencies and individuals (players). These are listed on the left hand axis of the process diagram (Figure 1) as follows:

Decision maker - Cabinet minister, Legislature.

Assessor - the agency having responsibility for preparing an environmental impact assessment. Department of government.

Proponent - the government agency or private company wishing to initiate an action with environmental implications.

Reviewer - the person, agency, or board with responsibility for reviewing an environmental impact assessment and assuring compliance with published guidelines.

Other Government Agencies - with technical or government interest in the project.

Expert Advisors - technical experts from government and non-government agencies.

Public - groups and individuals with interests in the project under study.

International - other national governments with interests in the project.

The stages of the process are given on the bottom axis of the diagram. It will be seen that different types and levels of baseline information are required to treat the project at each stage of the process.

Goals, Policy and Programs are developed by government and these stimulate the proponent to initiate and plan the project concept.

The Proposed Action is described by the proponent and, if there is potential for significant environmental effects, then the project plan is subjected to a *Preliminary Environmental Impact Assessment* This step is often taken according to guidelines issued by government. The environmental consequences are described from an analysis of existing information, expert opinion, and such reconnaissance surveys and studies as may be feasible within the time available.

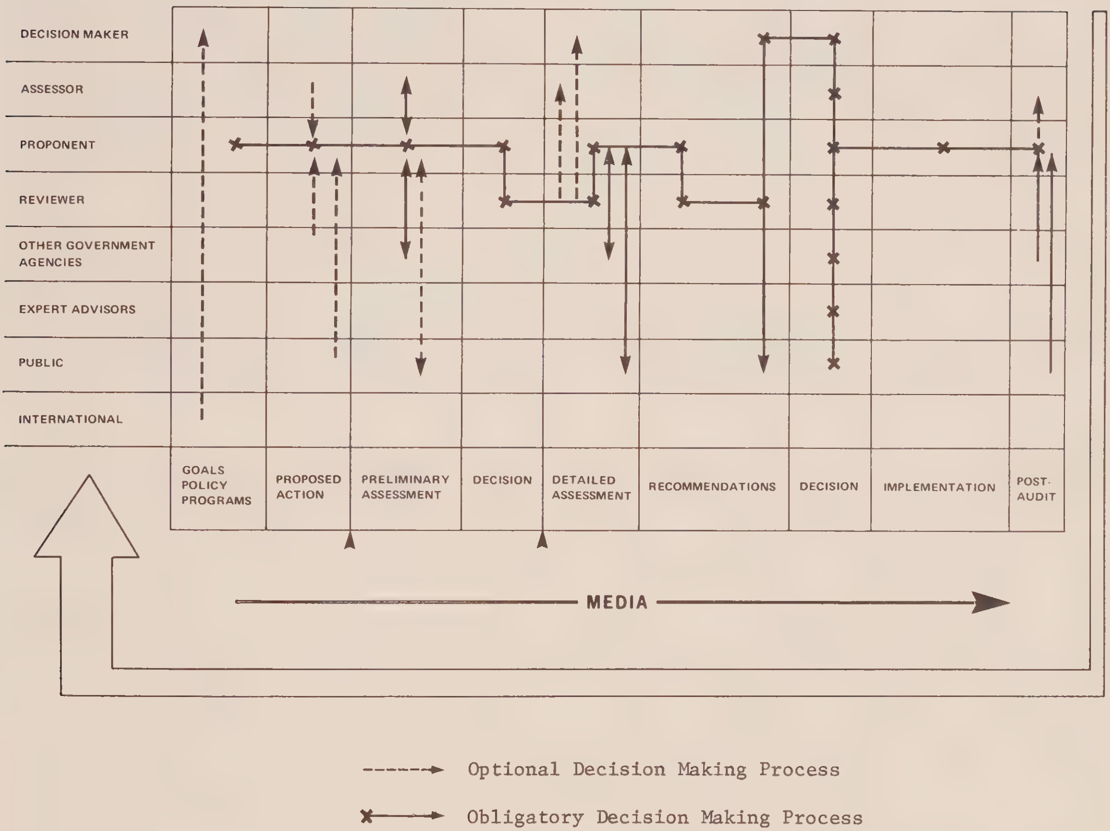
The *Reviewer* reviews the preliminary environmental impact statement* for completeness and objectivity and may require more information from the proponent. The Reviewer also determines

---

5 M. Walmsley, February, 1978, personal communication.

* Environmental Impact Statement - a summary of the environmental impact of an action and alternatives, including the non-action state.

Figure 1: Environmental Impact Assessment and the Review Process



if the proposal requires more detailed assessment. Lack of adequate baseline information may require that further studies be undertaken.

If the preliminary assessment is not sufficient, the proponent will be required to prepare a *detailed environmental impact statement*. Guidance for this stage comes from the preliminary assessment and from comments made during the review stage.

The detailed statement is prepared by the proponent and incorporates advice from technical experts and the public as the nature of the project requires. This stage may last several months and may require extensive baseline information gathering at a comparatively higher level of detail than earlier studies. The detailed statement should cover the total plan for the project, including alternatives and associated environmental consequences, together with *recommendations* and plans to mitigate environmental impacts.

The detailed statement is submitted by the Proponent to the Reviewer.

The Reviewer may consult with government for policy direction, and with technical experts, for advice.

When the Reviewer is satisfied that the detailed statement is sufficient, the statement is distributed to the public for comment. Sufficient time is allowed for the public to respond; sixty days in some cases. During this period the public may find it necessary to review the baseline information associated with the proposal as well as the detailed statement.

The Reviewer may hold public hearings on the project. Submissions from technical review agencies and the public may require the Proponent to provide additional information.

The Reviewer reports to the government Decision Maker on the detailed statement and the technical agency and public response to it.

The Decision Maker may require that the proposed project be proceeded with, modified, or abandoned.

The Reviewer prepares a report on its assessment and review and releases the report to the public.

The proposed project may then be cleared with any modifications deemed necessary.

The Proponent then proceeds with the final design, taking into account the environmental requirements - *Implementation*.

In the *Post-Audit* stage, surveillance and monitoring may be carried out during:

a) the final design stage

b) the construction stage

c) the operation stage.

Throughout the process the *Media* plays an important communications role and therefore possesses special needs in obtaining, analyzing and reporting on baseline information pertaining to the proposed project.

As the players participate in the process on a given subject, the process becomes a powerful educative tool in clarifying roles of participants and the importance of comprehensive and adequate baseline information at each stage.

One of the major advantages of ELC as a data base for environmental impact assessment is the flexibility of the system to scale and format. When new projects are in the initial planning phase, such as route finding for pipelines, a broad scale of ecological mapping serves the alternative corridor selection process. Once the preferred corridor is outlined then a more detailed scale of ecological mapping can be employed to select the final alignment. In each case ELC provides for the identification and description of ecologically sensitive areas and areas with major engineering and other problems such as slumps, fault zones, and highly productive land units.

For major projects which are the subject of detailed environmental impact assessment, the land system and land type seem to provide an adequate level of detail, particularly if integration of baseline information has taken place in the field. The multi-disciplinary team of specialists develops a list of ecological subjects which require continued surveillance in project planning, commissioning and operation.

In order for environmental impacts to be accurately predicted, an understanding is required of the processes which are at work in distinct environments, including geomorphological processes, river development, heat budget, food pathways, and faunal migration. Where land systems are identified, described, mapped and assessed in the field on the basis of productivity information and other data, then the ecological processes which are at work and which distinguish one land system from the other - these processes are better understood by the survey team and by impact analysts. As a result, the reported information permits a better assessment of project impacts with this process information taken into account.

There are some potential weaknesses or disadvantages to the ELC system:

1) The lead time required to plan, commission, and carry out an integrated survey of a large area of land or a corridor situation. This is a major problem on all projects reviewed to date notwithstanding the fact that ELC is time and cost efficient relative to other data gathering modes. The problem may be less acute with ELC than with other survey methods.

2) The aerial photo interpretation and mapping and description of land systems is a sophisticated scientific procedure which is sometimes difficult for the lay user to understand and appreciate. The individuals who best understand the land units are the scientists who identify, describe, and map the units. However the environmental impact assessment of predicted project effects is often carried out by other agencies and individuals. Unless the users understand the ELC methods and philosophy, the potential of the ELC baseline information is not always realized.

3) It is important that the ecological land classification surveyors understand the nature of the proposed project which is envisaged for the survey area in order to give due weight to examining ecological features which are particularly relevant to the proposed project.

4) The processes of environmental impact assessment and review which are employed by governments in Canada are not fully understood by resource and environment surveyors. It is important that the surveyors are cognizant of the stage at which a given project is in the planning and review process. This assists in establishing the level of detail necessary in the baseline information package to address the major questions at a given point in the process.

CONCLUSIONS

Ecological Land Classification has had limited application to environmental impact assessment up to the present time. However those applications which have been reported indicate that ELC has substantial potential as an organized, comprehensive and cost-efficient approach to baseline information assembly for this purpose.

REFERENCES

British Columbia Ministry of the Environment. 1977. Environmental Impact Assessments in Canada: A Review of Current Legislation and Practice prepared for the Canadian Council of Resource and Environment Ministers. 33 p.

Canada Committee on Ecological (Biophysical) Land Classification. 1977. Newsletter No.2. (ed. by E.B. Wiken). CCELC Secretariat, Ottawa, Ontario. 4 p.

Holland, W.D. 1976. Biophysical Land Classification of Banff and Jasper National Parks. *in* Proc. First Meeting Can. Comm. Ecol. Land Classif. (comp. and ed. by J. Thie and G. Ironside. Ecol. Land Classif. Series No.1 pp.221-238.

Hurtubise, F.G. 1977. A Guide to the Federal Environmental Assessment and Review Process. Environment Canada, Ottawa.

Jurdant, M. and V. Gerardin. 1977. La classification écologique du territoire au Québec un outil pour la gestion de l'environnement. *in* Proc. Sym. Ecol. For. Land Classif. in Canada and the N.W. USA. Vancouver, B.C. September 1977.

Munn, R.E. (editor) 1975. Environmental Impact Assessment Principles and Procedures. Scientific Committee on Problems of the Environment. Report No. 5. 160 pp. SCOPE, 51 Blvd. de Montmorency, 75016, Paris, France.

Subcommittee on Biophysical Land Classification. 1969. Guidelines for Biophysical Land Classification. (comp. by D.S. Lacate). Can. For. Ser Publ. No. 1264. Ottawa.

Wiken, E.B. and G. Ironside. 1977. The development of ecological (biophysical) land classification. Landscape Planning 4: 273-275.

Zoltai, S.C. 1976. Biophysical mapping in the Mackenzie Valley. *in* Proc. First Meeting Can. Comm. Ecol. Land Classif. Petawawa. Ecol. Land Classif. Series No. 1. Lands Directorate, Environment Canada, Ottawa. pp. 151-152.

METEOROLOGICAL SERVICES FOR ECOLOGICAL LAND CLASSIFICATION

B. F. Findlay
Environment Canada
Atmospheric Environment Service
Toronto, Ontario

ABSTRACT

A review is made of the facilities offered by the national meteorological observing network. Recent climatological studies which have pertinence to ecological (biophysical) land classification are reviewed by theme and according to whether they treat broad or small discrete areas, since the analysis techniques vary above and below the 1:2,000,000 scale. User response to these studies is cited in general. It is contended that most problems result from inadequate communications between client and contractor as to purpose and content of the specific study.

RÉSUMÉ

Il s'agit d'une étude des possibilités offertes par le réseau national d'observation météorologique, ainsi que d'une revue par thèmes des travaux récents de climatologie qui s'appliquent à la classification écologique (biophysique) du territoire. La revue est présentée par thèmes et en fonction de l'étendue de la région particulière couverte, avec des techniques d'analyse s'appliquant au-dessus et au-dessous de l'échelle 1:2,000,000. Le degré de participation des usagers est indiqué. Il est mentionné aussi que la plupart des problèmes sont imputables à un défaut de communication entre le client et l'entrepreneur à propos du but et de la nature des études. (Trad. Éd.)

INTRODUCTION

The Atmospheric Environment Service,(AES), a national meteorological service, has the responsibility for the collection and dissemination of a variety of atmospheric data much of which has significance for primary ecosystems. In view of the diversity of responsibilities accepted by the AES there occur many worthwhile areas of research and development where direct participation has not yet occurred or has been of a limited nature. The applications of meteorology and climatology to aviation, transportation and agriculture have been worked on over the years with some success, but the ways and means of using such information for land inventory and planning have unfortunately received less emphasis. Some notable contributions which have occurred were cited in an earlier paper (Findlay, 1976).

In view of its specialized nature the Atmospheric Environment Service is normally a support agency for environmental and land assessment and classification projects. The climatic capability for particular land-based activities: agriculture, forestry, recreation and industry is the usual scope of the exercise while other specialists assess the other physical and biological resources. Where air pollution is a significant factor meteorologists may play a lead role. This paper examines the pertinent work of AES scientists and others in the exploitation of the national meteorological archive and supplementary studies. Published material includes regional climatic studies along general and thematic lines according to the intended uses. As well, local studies (scales larger than 1:2,000,000) are undertaken to satisfy more specific themes. The response of users has been indicated where possible, but in general, it is fair to say that work in fields related to land evaluation comes from direct user requests. The degree of success of the response to users is largely related to the communication skills of the project participants on both sides.

Overview of the Climatological Data Resource

The AES operates an extensive meteorological observing network throughout Canada. Provincial agencies have also established networks usually in connection with the management of water resources and agriculture, but occasionally as in the cases of British Columbia and Quebec, for broader purposes. The AES national network, however, is larger than the others, by orders of magnitude. There are about 2,800 stations reporting presently. Historical stations, for which usable data are available exceed this number several times. The observing stations are of two principal types: synoptic stations, numbering more than 500, at which continuous observation and reporting of most meteorological parameters takes place; and secondly, climatological stations where temperature and precipitation are measured twice daily and reported once a month. In southern Canada the well-equipped synoptic stations are spaced about 300 km apart while the distance between climatological stations is about 40 km.

Stations which have been in place for sometime form the usable portion of the network. The ideal period is 30 years or more according to international agreement, but for many research projects a shorter record is adequate and in fact may be preferable since periods of homogeneous climate rarely last for the entire period (Court, 1968).

For many studies the density of the network may not be adequate. This is particularly true in mountainous and arctic areas where access is difficult and the population is sparse. Automatic stations are coming into more frequent use and there are plans to automate a large sector of the network in the 1980's.

The AES in conjunction with the World Meteorological Organization (WMO) has adopted standards of instrument exposure, station inspection, training of observers and the processing of data. The policy is to locate stations on relatively level terrain, remote from obstructions in the form of buildings, trees and other objects which may affect the broad area representativeness of the site. Local variants in the climate brought about by changes in terrain (valleys, slopes), vegetation, soils and land use cannot as a matter of economy, be fully documented in each case at this time, although in future it is hoped that each station site will be so systematically investigated. The study of regional topoclimates is certainly of great importance to ecological land evaluation.

DATA EXPLOITATION AND PUBLICATION

Expedient measures are taken to see that station instruments and operations meet quality standards. The need for rectification is often detected through the systematic testing of the incoming data prior to archiving and publication. Data summaries are published in the *Monthly Record of Meteorological Observations in Canada* and in other specialized bulletins issued on a regular basis.

The data are also utilized for regional and thematic studies which may be sub-classified to identify their use in ecological research. *Regional studies* are carried out to provide environmental information for development of a territory or to enhance existing uses. Examples are reports on areas of significant population and economic activity, for example the Great Lakes Basin (Phillips and McCulloch, 1972), or for areas of projected growth, for example the Mackenzie Valley-Beaufort Sea (Burns 1973, 1974). These are general climatologies having some specific user orientation (e.g. resource development, transportation). Mapping is at a scale of 1:10,000,000 to 1:5,000,000.

Thematic Studies are oriented toward a limited user such as a large scale hydro-electric project (James Bay development) or for agricultural or recreation and tourism planning.

REGIONAL THEMATIC STUDIES

Recreation and Tourism

A number of studies of the climate for recreation and tourism of provincial-size areas have been undertaken. The purpose has been to designate discrete areas of particular value for seasonal recreational pursuits. These studies are listed in Table 1.

YEAR	AREA	AGENCY/AUTHOR(S)
1970	Northwest Territories	AES/Crowe
1973-78	Ontario	AES/Crowe et al
1975	Maritimes	AES/Gates
1975	Newfoundland and Labrador	AES/Peach
1976	Prairies	AES/Masterton et al
1976	Northwest Territories*	AES/Crowe
1977	British Columbia	B.C. Environment/Bennett

* abridgement of 1970 study

Table 1: Regional Receation and Tourism Climatological Studies

It will be noted that the British Columbia study was published by the Environment and Land Use Secretariat of the provincial government. The work differs principally from the AES studies in that both synoptic and climatological station data are used and the classification of climatic capability is generally related to other ecological land assessments, affording direct value integration in the process of planning future land-use. By effectively using the climatological network, Bennett (1977) was able to include more stations, (highly desirable in a mountainous region), but he had to build his classification on temperature and precipitation data only. Such are the trade-offs in this type of work.

Part of the AES climatic classification has been previously outlined (Findlay, 1976). The system employs temperature, precipitation, wind, snow cover, humidity and cloud cover. Such parameters are measured only at synoptic stations. The classification scheme used in the Northwest Territories (Crowe 1970, 1977) differs from the other studies. It is based on parameters including daylength, temperature, windchill, visibility and cloud cover from which "ideal", "marginal" and "sub-marginal" criteria are derived for both winter and summer

User response to the AES studies has been, on the whole, positive. For example, the Ontario government has integrated the material into policy and strategic development plans which have received cabinet approval. Other studies prepared with the cooperation of the Department of Regional Economic Expansion should assist in sound tourist industry and other investment planning (Baker, 1975).

TABLE 2

FACTOR	WINTER			SUMMER		
	Ideal	Marginal	Sub-Marginal	Ideal	Marginal	Sub-Marginal
Daylength	>12 hr	6-12	<6		N/A	
Temperature (mean daily max.)	>-18°C	-26 to -18	<-26	> 10°C	< 10	N/A
Cloud Amount		N/A		< 50%	50-70	> 70
Wind (mean monthly speed)	<16 km/hr	16-25	> 25	< 16	> 16	N/A

Table 2: Climatological Rating Factors for Northwest Territories Recreation and Tourism Study (after Crowe 1970, 1976)

Agroclimatic Capability

The climatic capability of the Yukon and Northwest Territories for agriculture was assessed in 1975 and 1976 for the Department of Indian and Northern Affairs, Northern Natural Resources and Environment Branch. Previous information was given at the Petawawa meeting (Findlay, 1976). The final report (Eley and Findlay 1977) indicated that for an assessment area of nearly 50,000,000 ha, only 3,770,000 ha (7.5 per cent) were climatically suitable according to the classification developed in British Columbia as per Figures 1 and 2 (British Columbia, 1972). However, in applying the classification, it was found that land designated as 5G (one class below the arable range, being limited by a low seasonal heat accumulation) could produce crops such as potatoes when identified as class 4 or even class 3. As this land represents nearly 11 per cent of the area mapped it suggests that a major adjustment in the classification is required for use in the North.

The classification is based on growing-degree days (GDD), frost-free period, seasonal precipitation and the soil moisture deficit. The precipitation and soil moisture criteria were first adjusted to reflect the lower annual precipitation in the North. Instead of 250 mm of soil storage used in British Columbia, 75 mm was ultimately selected following hydrological testing. The Thornthwaite water budget procedure was followed.

The correspondence of crop types to the frost-free season limits defined in the B.C. classification was found to be good. For the cumulative growing-degree day parameters, problems were evident. It is noted, however, that there are relatively few sites within these vast territories where there is a contingent occurrence of crop cultivation and meteorological measurements. Moreover, the types of crops cultivated do not include all of the varieties listed for the B.C. classification and in fact there is a distinct bias toward crops favourably disposed to a long photoperiod. While photoperiod is not a rating factor in the B.C. classification, its effects offer a plausible explanation for why potatoes, for example, will mature with a seasonal accumulation of 950 GDD (°C) in the North when more than 1000 GDD are needed in British Columbia.

In view of uncertainties arising from the small sample and imperfect knowledge regarding crop responses to isolated climatic elements at many localities, the mapping of 45, 1:250,000 sheets was carried out using the B.C. system modified for soil moisture, but an interpretive guide and crop list was devised to explain a seeming lack of correspondence between crop behaviour and climate in several areas (Tables 3,4). The guide represents essentially a tentative second classification scheme which could be applied in future when more data are available.

TABLE 3

Revised Class	Range of GDD >5°C	B.C. Standard Range for Indicated class (>5°C)	Indicated Class on Maps	Frost-Free Period (days)	Soil Moisture Deficit (75 mm storage)
1	>1145	>1290	1,2 G	90 - 120	0 - 100
2	1000 - 1145	1145 - 1290	3,4 G	75 - 90	100 - 180
3	870 - 1000	1000 - 1145	upper 5 G	60 - 75	180 - 250
4	735 - 870	1000 - 1145	lower 5 G	50 - 60	250 - 300
5	615 - 735	735 - 1000	upper 6 G	30 - 50	300 - 350
6	500 - 615	500 - 735	lower 6 G	<30	350 or more
7	<500*	<500	7	<30	350 or more

* The cut-off level of 500 seasonal GDD is arbitrary. Some areas having less than this value may support grazing.

Table 3: Interpretive Classes for Assessing Agro-capability Levels Shown on Maps of the Yukon and Northwest Territories Prepared Using the Classification Developed in British Columbia

Table 4: Tentative Crop List for "North of 60" Agroclimatic Capability Assessment

CROPS	CLASSES						
Adaptable Season Vegetables (prefer temperatures 12-25°C)	1	2	3	4	5	6	7
Beans	X						
Celery	X						
Corn	X						
Cucumbers	X						
Green peppers	X						
Muskmelons	X						
Seed Onions	X						
Squash	X						
Tomatoes	X						
Cool Season Vegetables (no prolonged temperature above 20°C)							
Beets	X	X	X				
Broad beens	X	X	X				
Broccoli (sprouting)	X	X	X	X	X	X	
Brussels sprouts	X	X	X	X	X	X	
Cabbages	X	X	X	X	X	X	
Carrots	X	X	X				
Cauliflower	X	X	X				
Horseradish	X	X	X	?			
Kohlrabi	X	X	X	X	X	X	
Leaf lettuce	X	X					
Parsnips	X	X	X	X	X		
Peas	X						
Potatoes	X	X	X				
Radishes	X	X	X	X	X	X	
Rhubarb	X	X	X	X	X		
Rutabagas (and turnips)	X	X	X	X	?		
Set onions	X	X					
Spinach	X	X	X	X	X	?	
Swiss Chard	X	X	X	X	X	?	
Domestic Fruits *							
Apples	X						
Currants	X	X					
Raspberries	X	X					
Saskatoon Berries	X	X					
Strawberries	X	X					
Forage Crops							
Alfalfa	X	X	X	X	X		
Alsike clover	X	X	X	X	?		
Bromegrass	X	X	X	X	X	X	
Orchardgrass	X	X	?				
Reed canary grass	X	X	?				
Red clover	X	X	X	X	?		
Ryegrass	X	X	X	X	X	X	
Sweet clover	X	X	X	X			
Timothy	X	X	X	X	X	X	
Grains							
Barley	X	X	X	X	X		
Oats	X	X	X	X	X		
Polish rapeseed	X						
Winter rye	X						
Winter wheat	X						

* Wild varieties of currents, raspberries, strawberries and saskatoon berries are hardy and produce well under more severe climates.

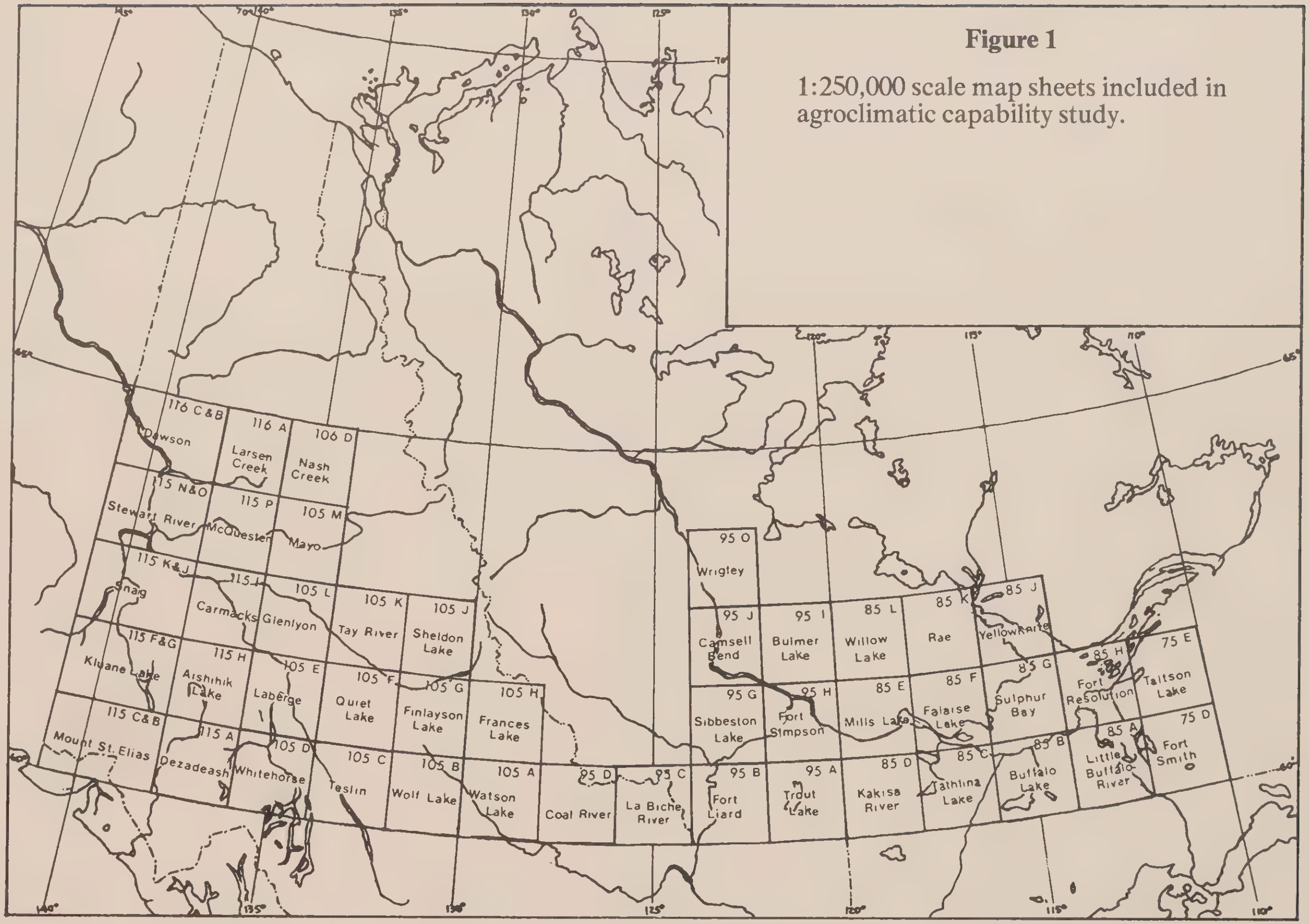


Figure 1: Extent of Agroclimatic Capability Mapping, Yukon and Northwest Territories

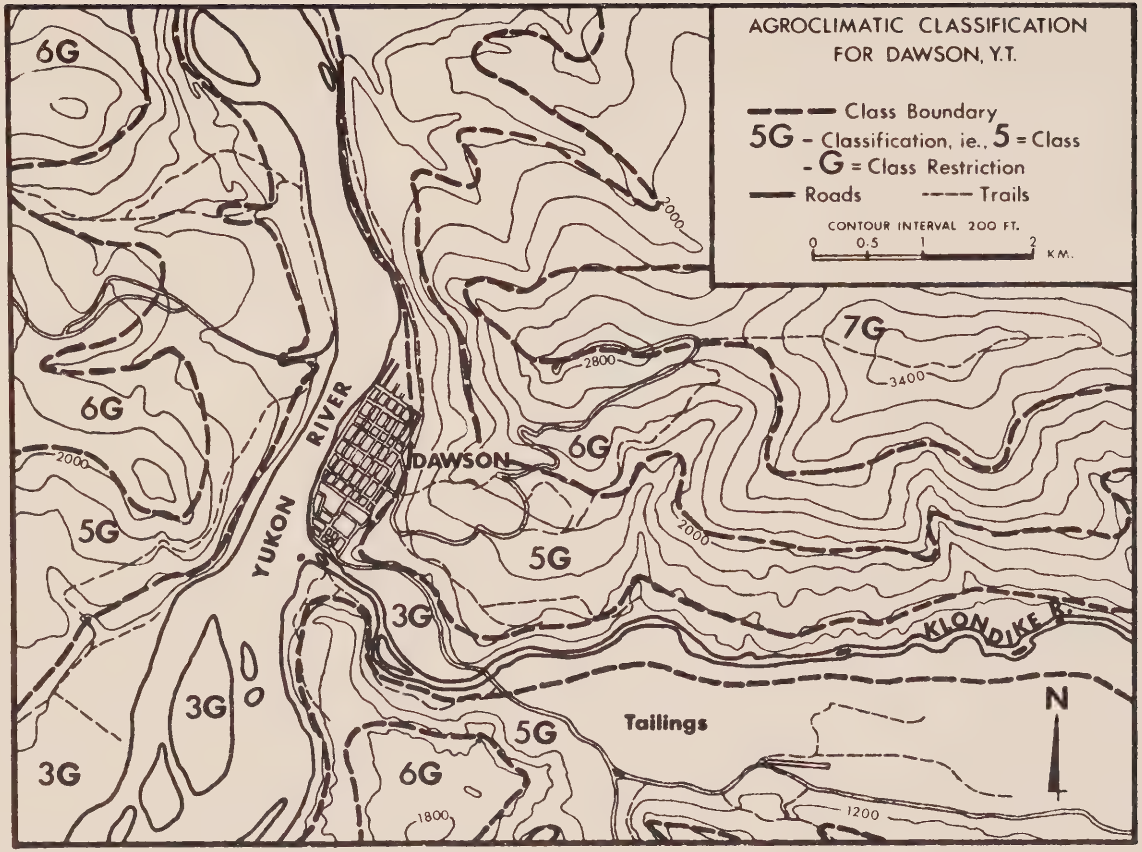


Figure 2: Example of Agroclimatic Capability Mapping in the Dawson Vicinity, Yukon Territory

Environmental Impact

Major land development schemes such as the James Bay hydro-electric power project have involved in-depth meteorological studies. It has been found in most cases, however, that data limitations have forced more generalized conclusions to be drawn than would be ideally desirable. Frequently the "analogous" approach has been resorted to where the results from studies undertaken elsewhere, but in similar climates and topography, are directly employed to postulate relative seasonal changes to the climate of the region under consideration. In the case of the James Bay project it was recognized that the existing meteorological network required immediate enhancement and about 30 new stations were put in operation in 1972-73. However, for real-time estimates of the foreseen impact of reservoir creation, recourse was made to studies in the USSR, western Canada and Alaska (Environment Canada 1975; Bondy, 1976). The effects were seen to be local - a small reduction in rainfall over spring and summer, and an increase in autumn precipitation, mainly snowfall. Greater wind speeds, fog, spray, icing, and somewhat lower annual evapotranspiration were also predicted. Schaefer (1976) studying the Williston Reservoir in British Columbia drew similar conclusions.

Aside from "analogy" and an enhanced network, the use of physical models to construct energy and water budgets has also been employed. Again, for the James Bay area, Vowinckel and Orvig (1974) and Perrier (1975) have suggested with some precision the climatic impact of hydro-electric power development. Models to generate spatial values are particularly apt for land use decisions. Henry (1965) projected the impact precipitation of the Rampart Dam in Alaska by actually showing forecasted isohyets. Such models are applicable to limited-area studies, for example where grid-point values may be computed.

LOCAL, LARGE SCALE STUDIES

Climatological studies at scales larger than 1:5,000,000, and in particular larger than 1:2,000,000 require detailed knowledge of terrain and water body effects on each element being examined. This is so that map values may be logically interpolated. Once data fields have been established, the scheme of analysis to present the information in the form required by the client must be decided. This may be illustrated by the experience of studies in national parks supplemented by some recent agrometeorological work.

Resource Management - National Parks

Beginning in 1973, the AES staff made a series of studies of Canada's national parks. Table 5 lists those studies completed to date. These studies have been characterized by progressively increased detail and aptness to the requirements of Parks Canada. This type of user has been identified by Baker (1975) as outlined on Table 6.

YEAR	PARK	AGENCY - AUTHOR(S)
1973	Pukaskwa (Ont)	AES-Findlay
1974	Wood Buffalo (Alta)	Private-Powell
1974	Kluane (Y.T.)	AES-Webber
1975	Riding Mountain (Man)	AES-Keck
1975	La Mauricie (Que)	U. Laval-Naud et al
1976	Prince Albert (Sask)	AES-Bauer
1976	Fundy (NWT)	St. Mary's U.-Day et al
1976	Auyuittuq (NWT)	AES-Masterton and Findlay
1977	Kejimkujik (N.S.)	AES-Watson
1977	Kouchibouguac (N.B.)	AES-Watson
1977	Banff, Jasper, Yoho Kootenay (Alta, B.C.)	AES-Janz and Storr
1977	St. Lawrence Islands (Ont)	AES-Lapczak et al
Unpublished		
1974 (in prep.)	Gros Morne (Nfld)	AES-Watson
1978 (in prep.)	Nahanni (NWT)	AES-Crowe et al

Table 5: Climatological Studies of National Parks in Canada

Table 6: Climatological Data Users at Parks Canada

Park Planning and Development		
a) Master Park Planner	-	selection of suitable types of activities and the general locations for their pursuit
	-	design of the communication network
	-	preparation of land-use and zoning plans
b) Landscape planner and architect	-	selection and design of buildings
	-	detailed site selection and orientation of structures
Park Management and Operation		
	-	natural environmental management and preservation planning, fire hazards, wildlife, rescue, etc.
	-	public use programme planning and operations
	-	information for remote area use, dangers to life from avalanches, exposure, etc.
	-	rescue planning - information dissemination programmes
	-	park natural history interpretation programmes

Over the period it has become clearer to the AES and other contractors just what form of information is needed to administer the parks. Parks Canada on the other hand has come to realize that the desirable detail regarding climatic effects on wildlife and vegetation may not be possible to provide without specialized instrument surveys. An example of a detailed communiqué of needs from the client to the contractor is provided in Table 7 for Fundy National Park.

The resulting 250 page report (Day et al, 1976) addressed itself well to these requirements and introduced a number of innovative ideas.

Experience indicates that raw network data in most parts of the country are not amenable to spatial analysis at scales greater than 1:2,000,000. It becomes necessary to develop topographical relationships (elevation, slope and aspect, distance from water bodies, vegetation, soils, etc.) in order to extrapolate climatic fields to the land system scale. The means by which this is done has been outlined in texts such as Geiger (1965) and MacHattie and Schnelle (1974). Other illustrations are given in the park reports themselves. For example Naud et al (1975) were able to utilize a number of detailed climatological studies of the Quebec Meteorological Service along with pertinent related experience in the Montmorency Forest to refine regional climatic maps according to the geographical features of the La Mauricie Park. In Pukaskwa Park, Findlay (1973) paired regional stations according to elevation, exposure and distance from the lake along with radiosonde data to develop generalized topo-climatological gradients for areas in which no measurements had taken place. Keck (1975) used objective analysis procedures developed in the weather office to generate by computer a network of grid-point values. Watson (1977 a,b) in a 1974 study employed 10 km grid data produced by regression analysis for an earlier water resource survey (Ingledow, 1970).

Table 7: Terms of Reference for Report on the Climate of Fundy National Park

a) a review, tabulation, analysis and synthesis of the existing climatic information and other related resource parameters;

b) a description of the climate of the project area and the relationship between the climatic regime and ecological land classification;

c) identification, delineation and description of the microclimatic zones in the project area;

d) a description of the interrelationships between the climate and other components of the project area environment (e.g. the effects of the climate on wildlife and vegetation);

e) a discussion of the suitability of the climate for outdoor activities generally associated with National Parks;

f) a discussion of the implications of the park climate for locating, planning and operating recreational facilities;

g) suggestions as to how the climate and climatic influences can be included in the park interpretation programme;

h) interpretation of the climate for planning patrol requirements (e.g. winter patrols, safety, clothing necessities);

i) interpretation of the data to aid the management of resources dependent on climatic variations and influences;

j) a discussion of the implications of the climate for fire management and control; and

k) a consideration of the important aspects and parameters influencing human comfort during park activities (e.g. exposure, wind chill factor, humidity).

Finally, Day et al (1976) generated multiple regression equations correlating eight independent variables from 24 observing stations, in and near Fundy National Park, to predict monthly temperature and precipitation values at 201 grid-points. The results were analysed subjectively.

The application of regression statistics to subsets of data from a variety of elevations and slope aspects is probably a "best" procedure when adequate station numbers and periods of record are available. It has been employed in British Columbia to analyse data from "swarm" climatological networks in the resource evaluation programme of 1:250,000 scale map sheets (Wilson, 1977). The "Shawinigan" method of gridding hydrological and climatological data at 10 km and 5 km intervals has been employed in several regions of Canada in order to refine standard network information (Soloman et al, 1968). Hopkins (1968) developed similar equations to predict temperature and precipitation normals over the Canadian Interior Plains and his work was refined and extended by Williams (1971). Recently Williams (personal communication) has incorporated "Shawinigan data" to better estimate agroclimatic capability for agriculture on the land system scale.

It must be emphasized that statistical relationships of this type apply only to the area in which they were developed. It is a dangerous practice to "export" such topoclimatic relations over considerable distances to data-sparse regions.

b) <u>Agriculture</u>

Microclimatology and meso-(or topo-)climatology were developed, for a large part, from the needs of agriculture and hydrology. Reference to the bibliography compiled by MacHattie and Schnelle (1974) attests to this. Extension of these concepts to other land planning requirements are illustrated by Primault (1972) in Switzerland or by the analysis of Schaefer and Nikleva (1973) for the third crossing of the Burrard Inlet (Vancouver) environmental impact statement.

Recent agrometeorological work indicates that this field continues to provide leadership in local scale climatology. For example, the airborne radiation thermometer (ART) is now becoming a useful tool in delineating frost-prone areas, and may be applied in regions where the road network is insufficient for automobile traverses. Stewart et al (1977) have reported on the utility of this technique in the Niagara fruit district, and ART flights are being undertaken in the Peace River District land evaluation project. The instrument detects the surface radiance from the infrared band, 8-13µ, and computes a black body temperature according to the Stefan-Boltzmann Law. Since most land surfaces are not black bodies, corrections for emissivity are required, and further adjustments are needed to make the values comparable with standard Stevenson screen temperature data.

In many areas, more traditional studies of frost zonation using vertical profiles from towers and automobile traverses continue to be carried out. Treidl et al (1978) report on such a study in a young orchard near London, Ontario.

CONCLUSIONS

This paper has had three broad intents:
(a) to outline the breadth of the climatological data resource;
(b) to illustrate the varieties of use of these data for purposes related to ecological land classification;
(c) to identify user response, problems, and project future activity.

Item (c) requires further comment now. In only a few cases are raw climatological data suitable for ecological land evaluation projects. Use requires selection, stratification and innovation. Most applications have a strong site-specific requirement. To overcome such complexities considerable discussion between the climatologist and the users of his data is often necessary. Such communications may be difficult to achieve. They require time, patience and a good "selling job" on the part of the climatologist.

The best results occur when the climatologist has time to join in the field program. In this way the proper data are selected for analysis. Usually long-term averages of temperature, precipitation, wind, etc. as published for general distribution throughout the country are not enough. Significant climatic events for nature and people need to be selected and described in terms of their frequency, range of severity, and duration. Sometimes the extent of impacts may be communicated through scenarios. This is a good method of clearly expressing an environmental *issue*, i.e. one which has ecological, social, and possibly economic implications.

By working directly with his data users the climatologist promotes and enjoys a two-way educative process. As an example, suppose that data from a regional meteorological station indicate that strong winds bringing uncomfortable conditions for picnicking occur every second day. However, picnicking may not be precluded if the terrain and vegetation offer a number of sites sheltered from the wind. Undoubtedly in such a simplified case, the climatologist would appreciate the degree of local variability in surface airflow. Nevertheless in other instances the advice of his colleagues from the related ecological survey disciplines could modify his conclusions or the emphasis he would place on certain aspects of the study. Much of this depends on the purpose of the end-product. In the environmental planning study of the Toronto waterfront, the climatologist Smith (1976) reported on what he felt were the important weather features. These were deduced in consultation with other biophysical workers and planners. The salient features which could clearly be related to the functioning of natural environmental systems and which had strong sensory effects on persons visiting the area were highlighted in the overall plan (Wallace et al, 1976) and strategies for land management of the lakeshore area were accordingly developed as outlined on Table 8.

TABLE 8

Climatic Region/ Feature	Social Values	Social Objectives	Performance Required	Land Use Implications
Urban-Harbour Transition Zone - openings between structures	- maintain comfort - preservation and protection of valuable resources. - desirability of providing amenity and development.	- optimize climate to encourage day/evening, year round use. - ensure that development does not adversely affect air quality.	- allow uninterrupted passage of lake breezes	- low intensity recreation (hiking, picnicking) moderate environmental modification is implied. Limited intensive recreation, playfields. Moderate restriction to major roads and transit systems to accommodate high-intensity traffic. - Small, low residential, commercial structures while desirable, are to be very limited in extent. High rises likely to be prohibited. Gaseous and liquid waste discharge to be severely restricted.

Table 8: Example of the Use of Climatological Resource Study in Synthesizing Land Use Policy for the Toronto Waterfront (after Wallace et al, 1976)

REFERENCES

Baker, W.M. 1975. The weather and climate interface with tourism and recreation - a user perspective. Seminar in Applied Meteorology for Meteorologists, Atmospheric Environment Service, Headquarters, March 3, 1975, 35 p.

Bauer, D.J. 1976. The Climate of Prince Albert National Park, AES, Meteorological Applications Branch Project Report No. 28, Toronto, 166 p.

Bennett, R. 1977. Climatic suitability for recreation in British Columbia, Ministry of the Environment, Victoria, 65 p.

Bondy, D.A. 1976. Prediction of climatic changes, Proceedings of the Symposium on the James Bay Environment, Montreal May 19-20, 1976, sponsored by Environment Canada and les Societés de développement et d'énergie de la baie James, p. 497-511.

British Columbia, 1972. Climate Capability for Agriculture , Environmental Land Use Committee, Climatology Report No. 1, Victoria, 11 p.

Burns, B.M. 1973 and 1974. The Climate of Mackenzie Valley-Beaufort Sea, AES Climatological Studies No. 24, Vol.1,2. Toronto, 466 p.

Court, A. 1968. Climatic normals are inefficient, American Meteorological Society Conference and Workshop on Applied Climatology, Asheville, N.C. Oct. 31, 1968, 27 p.

Crowe, R.B. 1970. A Climatic Classification of the Northwest Territories for Recreation and Tourism, Transport Canada, Canadian Met. Service, Toronto. 5 vol.

Crowe, R.B. 1975. The importance of climate to recreation - tourism facility planning. Canadian Meteorological Society, 9th Annual Congress, Vancouver, 18 p.

Crowe, R.B. 1976. A Climatic Classification of the Northwest Territories of Recreation and Tourism, AES, Meteorological Applications Branch Project, Report No. 25, Toronto, 232 p.

Crowe, R.B., G.A. McKay, and W.M. Baker. 1978. The tourist and outdoor recreation climate of Ontario, AES, Meteorological Applications Branch. REC 1-73, 3 vol., Toronto.

Day, E.D., R.S. McCalla, H.A. Millward, B.S. Robinson 1976. The Climate of Fundy National Park and the Western Study Area, St. Mary's University contract report for Parks Canada, Halifax, 250 p.

Eley, F.J., and B.F. Findlay. 1977. Agroclimatic Capability of outhern ortions of the Yukon and Mackenzie District, N.W.T., AES, Meteorological Applications Branch, Project Report No. 33, Toronto, 97 p.

Environment Canada, 1975. James Bay hydroelectric project-environmental concerns. Lands Directorate, Ottawa, 45 p.

Findlay, B.F. 1973. Climatography of Pukaskwa National Park, AES, Meteorological Applications Branch REC 2-73, Toronto, 46 p.

Findlay, B.F. 1976. Recent developments in eco-climatic classifications, *in* Ecological Land Classification Series No. 1, Environment Canada, Lands Directorate, Ottawa, p. 121-127.

Findlay, B.F., G.A. McKay 1975. Use of meteorology in Canadian land use planning, Proc. WMO Symposium on meteorology as related to urban and regional land use planning, Asheville, N.C., WMO No. 444, Geneva, p. 92-119.

Gates, A.D. 1975. The tourism and outdoor recreation climate of the Maritime Provinces, AES, Meteorological Applications Branch, REC 3-73, 133 p.

Geiger, R. 1965. The Climate Near the Ground, Harvard University Press, Cambridge, 611 p.

Henry, D.M. 1965. Possible precipitation changes resulting from the proposed Rampart Dam Reservoir, U.S. Army Cold Regions Research and Engineering Laboratory Tech. Rept. No. 147, Hanover, N.H.

Hopkins, J.W. 1968. Correlation of air temperature normals for the Canadian Great Plains with latitude, longitude and altitude, Can. Journ. Plant Sci. 5(2) 199-210.

Ingedow, T. 1970. Hydrometric network plan for the provinces of Newfoundland, New Brunswick, Nova Scotia and Prince Edward Island, Contract report to Dept. of Energy, Mines and Resources, Ottawa, 2 vol., 250 p.

Janz, B., D. Storr 1977. The climate of the contiguous mountain parks, Banff, Jasper, Kootenay, Yoho, AES Meteorological Applications Branch, Project Report No. 30, Toronto, 324 p.

Keck, A.J. 1975. (ed. R.B. Crowe) The Climate of Riding Mountain National Park, Manitoba AES, Meteorological Applications Branch, Project Report No. 19, Toronto, 258 p.

Lapczak, S., W.D. Wyllie, and R.G. Lawford. 1977. Climate of St. Lawrence Islands National Park. AES Ontario Region, Scientific Services Unit, 186 p.

MacHattie, L.B. and F. Schnelle. 1974. An introduction to agrotopoclimatology. World Meteorological Organization, Tech. Note No. 133, Geneva, 131 p.

Masterton, J.M., R. Crowe and W. Baker. 1976. The tourism and outdoor recreation climate of the Prairie Provinces, AES Meteorological Applications Branch REC-1-75 Toronto 221 p.

Masterton, J.M. and B.F. Findlay. 1976. The climate of Auyuittuq National Park, Baffin Island, N.W.T., AES, Meteorological Applications Branch, Project Report No. 22, Toronto, 108 p.

Naud, R., A. Plamondon, G. Lemieux, J.L. Breault, and A. Galposoro. 1975. Hydologie et climatologie du parc national de la Mauricie, rapport preparé pour Parcs Canada, Québec, 215 p.

Peach, J.A. 1975. The tourism and outdoor recreation climate of Newfoundland and Labrador, AES, Meteorological Applications Branch Project Report No. 20, Toronto 242 p.

Perrier, M.G. 1975. Influences de modifications de surface sur le climat (Région de la baie James), McGill University Publication in Meteorology, No. 116, Montreal, 132 p.

Phillips, D.W. and J.A.W. McCulloch. 1972. The climate of the Great Lakes Basin, AES, Meteorological Applications Branch, Climatologial Studies No. 20, Toronto, 40 p.

Powell, J.M. 1974. Climate of Wood Buffalo National Park, typescript, Parks Canada, Calgary.

Primault, B. 1972. Étude méso-climatique du canton de vaud, Office cantonal vaudois de l'urbanisme, Cahiers de l'aménagement régional 14, Lausanne 1972, 186 p.

Schaefer, D.G., 1976. Climatological impacts of Peace River regulation and a review of the possible effects of climatic change on agriculture in the area, Report prepared for B.C. Hydro and Power Authority by the AES Pacific Region, Scientific Services Unit, 60 p.

Schaefer, D.G., and S.N. Nikleva. 1973. Mean precipitation and snowfall maps for a mountainous area of potential urban development, Proc. 41st Western Snow Conference, p. 80-89.

Smith, R. 1976. Climate. Central Waterfront Planning Committee, Toronto.

Stewart, R.B., E. Mukammal and J. Wiebe. 1977. The delineation of frost prone areas in the Niagara fruit belt – a joint study of the AES and the Ontario Horticultural Research Institute, Ministry of Agriculture and Food. AES Technical Report. Toronto, 16 p.

Treidl, R.A., E. Birch and P. Sajecki. 1978. The microclimate of an orchard in southwestern Ontario during spring: a report on air drainage and inversions, AES Agrometeorological Report No. 2, Toronto, 19 p.

Soloman, S.I., J.P. Denouvilliez, E.J. Chart, J.A. Woolley, and C. Cadou. 1968. The use of a square grid system for computer estimation of precipitation, temperature, and runoff Water Resources Research 4 (5):918-929.

Vowinckel, E., and S. Orvig. 1974. Meteorological consequences of natural or deliberate changes in the surface environment: general principles with examples from the James Bay region, McGill University Publication in Meteorology No. 112, Montreal, 37 p.

Wallace,McHarg, Roberts and Todd 1976. Environmental Resources of the Toronto central Waterfront. Central waterfront Planning Committee, Toronto, 130 p.

Watson, W.B. 1977a. The Climate of Kejimkujik National Park, Nova Scotia, AES, Meteorological Applications Branch, Project Report 26, Toronto 109 p.

Watson, W.B. 1977b. The climate of Kouchibouguac National Park, New Brunswick, AES, Meteorological Applications Branch, Project Report No. 27, Toronto, 111 p.

Webber, B.L. 1974. The climate of Kluane National Park, Yukon Territory, AES Meteorological Applications Branch, Project Report No. 16, Toronto, 319 p.

Williams, G.D.V. 1971. Wheat phenology in relation to latitude, longitude and elevation on the Canadian Great Plains. Can. J. Plant Sci. 51: 1-12 .

Wilson, R.G. 1977. Climatic classification: tools for land use planning in British Columbia, Proc. 6th B.C. Soil Science Workshop, Vancouver, April 20-21, 1977.

ECOLOGICAL MAPPING AND SOCIOECONOMIC STATISTICS

A. Friend
Advisor on Environmental Statistics
Statistics Canada
Ottawa, Ontario

ABSTRACT

The paper describes Statistics Canada's approach to the development of a comprehensive framework for environmental statistics. Efforts to modify the National Accounts to obtain net social benefit estimates are discussed with particular emphasis on the conceptual limitation of introducing environmental damage costs estimates. Alternative approaches based on material-energy balances and statistical frameworks of the "stress-response" interface of human activity and the environment are examined. The development of the latter system is in response to the growing awareness of the inadequacy of a framework based on traditional categories of water, air, land, etc. The integration of socioeconomic statistics with biophysical data is emphasised. The final section of the paper identifies the major stressors on the environment where socioeconomic data describe at a macro-level the human activities and monitoring re cords providing the indicators of the state, and change of state, of the environment.

RÉSUMÉ

Ce rapport porte sur la stratégie d'élaboration par Statistique Canada d'une base globale pour la statistique environnementale. Il y est traité des efforts visant à modifier les bilans nationaux de manière à obtenir des évaluations des avantages sociaux nets, et particulièrement des limitations conceptuelles de la formulation d'évaluations des dommages environnementaux. Il y est aussi question des solutions de rechange fondées sur les bilans matériel-énergie et les cadres statistiques du rapport stress-réaction en ce qui concerne l'homme et l'environnement. Il importe de poser ces cadres en raison de la prise de conscience croissante de l'insuffisance des méthodes fondées sur les catégories classiques du milieu, soit l'atmosphère, les eaux, les terres, etc. L'auteur insiste sur la nécessité d'incorporer les statistiques socioéconomiques aux données biophysiques. La section terminale du rapport constitue un relevé des principales pressions exercées sur l'environnement, les données socioéconomiques décrivant à l'échelle d'un macro-système les activités humaines qui influent sur l'environnement, et les registres de contrôle constituant des indicateurs de l'état du milieu et de ses fluctuations. (Trad. Éd.)

INTRODUCTION

The synthesis of ecological space with that of "human activity space" is probably one of the most crucial elements in the design of an information system on the environment. The purpose of this paper is to review the experience of Statistics Canada in the development of environment statistics, starting with a brief summary of the issue of introducing environmental factors into the National Accounts. The reason for this is that these accounts not only provide influential indicators of economic performance but also represent in a symbolic sense the idea of progress. This will then be followed by a discussion of alternative approaches being developed in Statistics Canada.

There is striking evidence of a convergence in thinking between the social scientist and natural scientist in what are the desirable characteristics of an information system on the environment. These can be briefly summed up as the need for a synthesis of socioeconomic data with biophysical data, and that interaction of the environment and man should be viewed from the perspective of processes, both in terms of'natural'and'human'controlled.

THE SYSTEM OF NATIONAL ACCOUNTS AND THE ENVIRONMENT

The System of National Accounts (SNA) can be described as an integrated data base of economic - institutional - transactions. From these accounts a number of national aggregates can be derived, among them are GNP, gross capital formation, consumption expenditure, government expenditure, national income, etc. These indicators measure, essentially, economic performance and influence, at a high level of decision making, the allocation of resources. One of the major objectives of the 'environmental movement' is to influence decision-making at all levels of governments by making explicit the environmental costs of alternative options and actions. It was largely this objective that stimulated the efforts to modify the SNA to account for environmental factors.

The current methodology for assembling the SNA include environmental factors, if at all, only implicitly. Scarcity of natural resources could for example be reflected through the price mechanisms, which in turn may show up as a decline, substitution or a relative shift in use. Similarly the public demand for better quality environments could show up as increased private or public expenditure on pollution abatement and environmental management. Nonetheless most of the cost-benefit of the environmental factors are hidden — cost of respiratory diseases due to pollution would be part of health expenditure; the travel time and energy used to seek out unspoiled recreational lands would be included in travel and transportation accounts; other items such as psychic benefits from preservation of wild species would never be included as they would not enter the economic-transaction stream. The essential paradox is that most costs attributed to degraded environments contribute to the growth of GNP.

Several proposals have been forthcoming to suggest methods to modify these accounts in an effort to produce more welfare oriented aggregates. All these techniques, in the final analysis, depend on calculating 'bads' to derive a net benefit of the goods and services produced. To obtain a value for the bads, except those that have a real market price, or could be given a surrogate market value, e.g. loss of property due to floods, loss of value of agricultural lands due to urbanisation, etc., requires subjective evaluations. The introduction of "subjective value judgement" in the accounts would quite legitimately create confusion on how to interpret them. This does not, however, mean that damage functions of environmental deterioration should never be made, but rather, that they are recognized as a separate exercise for the purpose of cost-benefit analysis.

Perhaps the most telling argument for avoiding the "market calculus" for the loss of functions of environmental assets is the severe limitations of the economist's paradigms. Among these is the concept of *time discounting* whereby future streams of benefits are discounted to *present value* by increasingly diminishing the value of the future; this makes eminent sense for capital investment theory but sounds slightly ridiculous to reduce all environmental assets to that of long term investments. The problem lies in that the theory of value assumes that all assets are reproducible and/or substitutable e.g. swimming pools for polluted beaches. Thus, at least in principle, permanent loss (non-reproducible) has no value or has a value of infinity - permitting, perhaps, the surrogate value to be a function of the whim of the calculator!

The point at issue is not so much the conceptual framework of the SNA but rather the unwarranted normative values placed on the national aggregates. The purpose of the system is to monitor economic activity within a strict economic-institutional paradigm, and is poorly suited to accommodate non-market concepts of value. The introduction of "damage function estimates" would merely add to the already difficult interpretation of these accounts with hardly any compensating insight into net social benefit. The damage cost approach should be clearly distinguished from the more modest "measure of economic welfare"[1]. These efforts are directed at expanding the concept of production and consumption so as to arrive at a better appreciation of their functional relationships. Thus, for example, the value of housewife services would be added to GNP whereas the cost of travel to work would be an intermediate cost of production and thus subtracted from GNP.

ENVIRONMENTAL INFORMATION — AN ALTERNATIVE PARADIGM

Statistics Canada is the central statistical agency responsible for the collection, compilation and dissemination of socioeconomic statistics of national interest. The agency also has a role in integrating and

(1) Hawrylyshyn, O. 1976. A Review of Recent Proposals for Modifying and Expanding the Measure of GNP. Statistics Canada, Ottawa. Cat. No. 13-558.

coordinating statistics generated by other federal government agencies. The Bureau has embarked, since 1972, on the development of environmental statistics in response to the growing concern of the impact of man's activity on the state of the environment.

From the beginning there was recognition of the fundamental dichotomy of environmental statistics. These have been referred to as (socioeconomic) statistics covering activities of man as agents of environmental change, and (scientific) monitoring data on the state of the environment. It is this rather unique element of correspondence of biophysical and socioeconomic measures that distinguish environmental statistics from the traditional areas of statistics. Nevertheless, it has taken several years to understand the nature of environmental statistics and, in particular, the kind of framework required to integrate and coordinate their development.

It has become increasingly clear that statistics on the environment require two rather distinct although complementary paradigms. One capturing the phenomena of the stock-flow of materials and energy and the other the stress-response interaction of human activity and the environment.

The systemic organisation of statistics that track the physical flows of materials and energy through various processes of production and consumption is now being considered in Statistics Canada in close cooperation with the United Nations Statistical Office[2]. This is a macrosystem closely allied to the input/output model of economic activity; albeit in physical rather than monetary terms.

The stress-response paradigm on the other hand is an attempt to marry macro-activities (referred to as "stressor activities") with spatially identifiable environmental response. The purpose of the system can be summed up as providing the data base for three fundamental concerns:

(i) Stewardship: the need to protect and conserve environmental assets for future generations;

(ii) Environmental Quality: the need to maintain and enhance the quality of the ambient environment for quality-of-life objectives;

(iii) Irreversibility: the need to make explicit the closing of potential options by man-initiated permanent restructuring of the environment, i.e. destruction of ecosystems.

The application of these concerns ranges from very local situations to those on a world-wide scale; e.g., the destruction of the ozone layer. One of the most difficult development areas is the specification of appropriate indicators that can act as danger signals of ecosystem instability and eventual collapse.

The development of an environmental statistical data base requires the establishment of the appropriate spatial entities. The current use of administrative boundaries is on the whole unsatisfactory for describing environmental transformation. The stress-response paradigm naturally focuses on the question of how to integrate stressor activity with that of environmental response. Ecological mapping can play a crucial role in this domain, particularly if a satisfactory correspondence can be made between "stress-impact space" and "biophysical space". Unfortunately the stress-impact space is variable both with respect to types of stresses and the physical properties of the ambient receiver environment. Although we have no satisfactory answer on how to designate appropriate spatial entities we do have some idea of the desirable characteristics. Furthermore it is recognised that these spatial units will be based in essence on a compromise between 'idealised' scientific criteria and the socio-political criteria, including 'arbitrary' administrative boundaries. In other words the spatial entities must accommodate both the decision making space and the natural process space. The following three criteria may be useful in considering the nature and characteristics of environmental space for decision making purposes[3]:

(i) that the terrain of the country be divided into natural units which make sense in ecological terms;

(ii) that these natural units be classified on a hierarchical basis, i.e. biomes and their subcomponent ecosystems, which can be aggregated into areas that

(2) For a description of the system see: Draft Guidelines for Statistics on Material — Energy Balances. E/CN3/492 Geneva, Nov. 1976.

(3) Rapport, D. 1976. Towards a Comprehensive Environmental Data System for Canada, the Needs for Data. Interdepartmental Comm. on Environmental Statistics. Working Paper.

are well matched to the space-time horizons of decision making at regional, national and international level;

(iii) that the correspondence between "stress-impact space" and natural units be designated so that the recorded information show not only indicators of the state of the environment, whether natural or already transformed by human activity, but also show the major human activities which influence the state and its future transformation.

In considering the nature of ecological land classes that provide the essential overlay of human activity and the environment it may be useful to briefly review the conceptual underpinning of the stress-response system. The following paragraphs which describe "S-RESS" taken from a paper entitled *Frameworks for Environmental Statistics: Recent Experience of Statistics Canada* prepared by the author for a meeting of the United Nations Economic Commission for Europe on Environmental Statistics held in Geneva in January 1978.

STRESS-RESPONSE ENVIRONMENTAL STATISTICAL SYSTEM (S-RESS)

A Framework for Organizing Environmental Statistics

The system as outlined below was in part a response to the growing awareness of the inadequacy of a framework which organized statistics along the traditional categories of air, land, water, noise, etc. This may seem somewhat surprising because a priori the development of statistics based on traditional sectors appeared both reasonable and logical, notwithstanding the inherent danger of ignoring potential interactions. Nevertheless, from the perspective of scientists, these categories were both artificial and naive, and the underlying logic appeared to have more to do with the convenience of management and administration rather than the innate qualities of the natural environment. A functional approach made more sense when the process of environmental change was taken into account. It was for this reason that the stress-response relationships were considered as useful concepts for integrating statistics on the state of the environment.

Another consideration in the design of the system was the recognition that for policy purposes the identification of the source of stress was often more important than merely knowing the state of the environment. This is particularly relevant when considering longer-term policies directed at the reduction of environmental stress by modifying production and consumption processes.

The two major sources of environmental statistics are those that are derived from monitoring records of the state of the environment, and those that are derived from surveys of activities that can be said to be agents of environmental stress. The latter statistics are essentially socioeconomic and can be referred to as "macro-data" showing secular trends and/or broad spatial distribution of activities. In contrast, the monitoring records are obtained from physical measures, usually with a high level of spatial and temporal specificity. These can be referred to as "micro-data". S-RESS is an attempt to integrate the data sets from both the macro and micro data sets within a single framework.

Socioeconomic statistics, however, are generally produced for purposes other than environmental studies. The S-RESS framework, therefore, provides a methodology for identifying the variables required for environmental purposes. One key aspect is to draw out the spatial dimension of socioeconomic data. This could be achieved by introducing geocodes on regular surveys based on natural entities such as river basins, biomes, etc. Furthermore, existing surveys could be modified to draw out information on such items as the production and uses of hazardous substances, the content and disposal of solid wastes, the cost of installation and maintenance of pollution abatement equipment, and the use of energy. Government departments are now undertaking several inquiries in response to data needs for environmental purposes, yet, on the whole, these are viewed as ad hoc inquiries rather than a systematic development of data. Appendix 1 lists the kinds of data that can be obtained from regular socioeconomic surveys.

The major characteristic of the framework is its focus on the interface between the production-consumption activity of man and the transformation of the state of the environment. Not all environmental stress is man-originated however, and recognition must also be given to the effect of natural forces. Indeed, the 'ecological disasters' in the past can be largely accounted for by the synergistic effect of nature and man's activity. We need only recall the 'dust bowl' of the 1930's in the American Prairie, a synergistic effect of inappropriate agricultural practices and prolonged drought.

A second characteristic of the framework is to use concepts of environmental stress and environmental response. The basic structure of the framework is based on the recognition

of distinct, although related, classes of data from which different aspects of the condition of the environment can be measured. One set of data is derived from monitoring directly the state of the environment. In this set, distinctions can be made between emissions into environmental media — referred to as *stress measures* — and those that measure the effect of stresses on the quality of the media and the health of biological species (including man) — referred to as *response measures*. A second set of data measures global activity with a parallel stress and response. On the stress side, they have been referred to as *stressor measures* which relate to aggregate activity. The other global measures relate to, for the most part, the response of man or his governments, i.e. to "stressed environments". These will be referred to as *collective and individual responses*.

A third characteristic of the framework is to make explicit, as far as this is possible, the relationship between micromeasures, i.e. monitoring of the state of the environment, with measures of aggregate activity. This is a difficult task. First, because the knowledge of man-environmental interaction is still rather fragmentary and there are no well developed models that would permit an easy selection of the relevant parameters. Second, although environmental managers are quite familiar with local conditions, it is quite a different matter to correlate what is happening locally in the context of overall activity; in other words, to link in real time local micro-data with that of macro-statistics. Nevertheless, it is precisely this kind of 'cause-effect' relationship that is required for the formulation and implementation of policies and the judicious allocation of national resources.

The groups of data mentioned above are essentially "activity measures"; that is, they refer to "flow data", but frequently flows are significant in the context of the available *stock*. Thus, to balance the picture, a third group of measures have been made explicit — those drawn from stock accounts. These could also include the mapping of environmental resources. This distinction between flows and stocks is the fourth characteristic of the framework.

In summary, the five classes of data are: (i) stressor measures, (ii) stress measures, (iii) response measures, (iv) collective and individual responses, and (v) related inventory measures.

The basic framework of the system is shown in Figure 1. The interactive elements expressed in terms of stress-response relationships are shown along the horizontal plane, and the major activities that can be considered as sources (potential) of stress are given along the vertical plane. The system is recursive in the sense that collective and individual responses act upon (or modify) the stress elements. These can be distinguished by three types:

(i) Those that are directed at modifying processes of production and consumption with the intent of reducing environmental stress: to the extent that these actions act upon the sources of stress (stressors) they can be classed as *preventive actions*. (Although preventive in a more fundamental sense would require an action that would stop a particular activity before the stress even occurred.)

(ii) Those that are directed at modifying the level of stresses: these are actions that act upon the stress elements, and are perhaps most familiar in pollution abatement activity. This class of activity can be classed as *curative actions* in the sense that they do not act upon the fundamental process change but rather ameliorate the conditions.

(iii) The third type relates to a whole range of actions that are directed at conservation and protection of environmental assets in the broadest sense. Although *conservation actions* could be applied to process changes, e.g. energy conservation, the more direct actions are those that preserve and conserve renewable and non-renewable resources. Designation of land use with special legislative protection is one type of action; e.g. national parks, wildlife refuges, landscape protection, etc. The other is directed at the conservation of non-renewable resources. A sine qua non for a sound statistical basis for these actions is comprehensive inventories of natural assets ranging from the best available estimates of non-renewable resources to complex ecological mapping exercises.

Type of Statistics

	Measures to Reduce Env. Stress: A	B		Policy Response	Conservation Measures: C
Activity	Stressors Measures →	Stress Measures →	Environmental Response Measures →	Collective and Individual Response	Inventory of Stock Measures
I Generation of Waste Residuals	Production and Consumption	Pollution loadings	Monitoring of Env. Quality	Abatement Expenditures and Process Change	Capacity to Abate Pollution and Recycling Capacity.
II Permanent Env. Restructuring	Construction and land use change	Construction and land use change at local level.	Ecosystem Transformation	Protection and Conservation of Env. Assets Environmental impact assessment.	Accumulated Stock of Man-Made Structures Area of Protected Env.
III Harvesting Activity	Production from Renewable Resources	Over-production and Technological Stresses	Sustainable Yield Response	Control of Technology and establishment of quota systems.	Stock of Renewable Resources
IV Extraction of Non-Renewable Resources	Production and Consumption and Alternative Substitutes	Same as I and II	Same as I and II	Conservation Measure	Stock of Non-Renewable Resources
V Production and Consumption of Potentially Hazardous Substances	Production, Disposition and Disposal	Application of P.H.S. and leakage	Level of Contaminents in the Environment	Restrictions and Control of use of P.H.S.	Stock of P.H.S.
VI Production and Consumption of Energy	Production and Use	Development of Supporting infrastructure Thermal loadings. Noise generations.	Thermal Pollution, (Noise) nuisance	Energy conservation	Stock of Energy Resources. Capacity of energy Production.
VII Natural Activity	Meteorological Records and Geo-physical Events	Variation of Climate and Geo-Physical Events Beyond Normal Range	Drought, Flood, Earthquakes and long term Biome Change	Socio-Economic Response to Natural Activity	Mapping of Climate and Ecological Zones.
VIII Population Dynamics (Human and other Biological Species)	Population Change on Temporal and Spatial Dimensions	Population in Relation to Carrying Capacity	"Over use" of Natural Resources. Increase in Mortality and Morbidity	Control of Population Size and Habitat Expansion	Population Count

A. Preventive Actions (e.g. change in processes of production and consumption).
B. Curative Actions (e.g. installation of pollution abatement equipment).
C. Conservation Actions (e.g. policies to restrain the use of, and protect, environmental assets).

Figure 1: Structural Framework for the Stress-Response Environmental Statistics System (S-RESS).

STRESS-RESPONSE: SOME DEFINITIONS AND CONCEPTS

Although the definitions and concepts given below attempt to distinguish stress from response, there is, nevertheless, a degree of relativity between them. That is, stress in one system may be a response in another. Thus, a leakage of mercury into water is a stress on the life support system, with one response being the concentration of mercury in water, which itself is a stress when ingested by fish (the response being p.p.m. of mercury in fish). This in turn is a stress on human health when the same fish are eaten by man. However, for the purpose of the framework, the definitions are to be viewed as organizing principles for a set of statistical data related to man's activity and the state of the environment. The *stress-response* is then seen from the perspective of the impact of man's activity on the environment in which *stressors* are, in a sense, the independent variables and the stresses and responses the dependent variables of the system.

Stressors can be defined, for statistical purposes, as a broadly based set of activities that contains within it the potential to degrade the quality of the natural environment, to effect the health of man, to threaten the survival of species, to place pressure on non-renewable resources, and to deteriorate the quality of human settlement. They are both man-made and natural in origin. Stressor measures are non-specific with regard to point location and provide the statistical measures to assess the *global impact* of stress on the environment. They essentially provide the background information to assess global economic activity and the state of the environment. Examples: industrial activity, population density, transport networks.

Stress can be defined as the elements that place pressure on, and contribute to the breakdown of, the natural and man-made environment. To distinguish it from stressors, the "target" of the stress should be known. Thus, SO_2 pollution data of Toronto would be classed as stress statistics because the target (the residents of the city) are a readily identifiable group, whereas national totals of SO_2 emissions would be classed as stressors — since the response target, the national population is too diffused to identify it with a specific response group. *Stress measures* are generally derived from micro-statistics, such as monitoring data, are from location-specific records, and provide measures to assess stress on the spatially defined environment: examples, emissions of pollutants, noise, etc.

Environmental responses can be defined as the observed effects of stress upon natural and man-made environments. Assessment of the state of the environment can be viewed as a process of evaluating the response of the environment to stress. It is, however, a difficult and complex task requiring knowledge and understanding of the different levels of responses. In this framework, it is proposed that the distinction be made between responses that permit a direct link with the source of stress and tend to be visible, from those that are indirect and diffused in terms of linking the source of stress with the response. The latter would include the "health" response of living organisms, the quality of life-support systems, and impacts on ecosystems. The former would include, inter alia, response of environmental media to emissions and the visible impact of infrastructures. To make the distinction between these two levels of responses, one could refer to *direct response* and *indirect response*.

Direct response measures would be made up of a class of statistics on concentration of pollutants in environmental media, concentrations of contaminants in living organisms, land use change, etc. *Indirect response* measures would include statistics on environmentally-caused morbidity, extinction of species, and measures of the health of ecosystems.

Collective and individual responses can be described in broad terms as man's reaction to environmental changes. These can be further distinguished by actions of governments (collective action), individuals as members of households, individuals as legal entities; i.e. enterprises, and group actions — e.g. public pressure groups. Statistical measures in this area would be those that describe and evaluate government policies, the 'defensive' or 'escape action' of individuals, the actions of environmental pressure groups, the expenditure of enterprises on pollution abatement, the perceptions and attitudes of people toward the environment, etc. The actions related to conservation and protection of environmental assets would be captured as a collective response to stewardship and quality-of-life objectives.

STRESSOR ACTIVITIES

Stressors (or sources of stress) are the independent variables from which the data sets are organized in S-RESS. Thus, a key aspect of the system is the identification of a set of stressors which cover the universe yet are sufficiently broken down in detail to provide a basis for concrete developmental work. This would be easier to do if the scientific

knowledge of the structural parameters of man's interaction with the environment were better established. Although taxonomies, in the final analysis, are constructs for simplifying reality, they often provide the basis for the first approximation of a paradigm for 'real world' behavior. The set of activities identified below can be viewed as a minimum required to cover the most fundamental environmental issues in terms of structural parameters of environmental transformation.

The first four activities listed can be said to be structural in the sense that there is a close one-to-one correspondence between the type of activity and a basic structural concern of environmental transformation. These are:

(i) Generation of Waste Residuals;

(ii) Permanent Environmental Restructuring (man-made);

(iii) Harvest Activity (renewable resources);

(iv) Extraction of Non-renewable Resources.

The second set of activities relates to specific environmental concerns — although, in principle, they could be subsumed in (i) to (iv) above. They are:

(v) Production and Consumption of Potentially Hazardous Substances;

(vi) Production and Consumption of Energy.

Other types of activity could be considered in this context, particularly as a response to emerging environmental issues. In a country in which tourism plays a significant economic role, there may be a case for singling out this "stressor" activity for special treatment. Other examples could be urbanization, transportation, and spread of new technologies. However, it should be clearly noted that there is a tradeoff between a taxonomy based on a minimum set of "simple" stressor activities from those which are essentially "compound" stressor activities. The latter, if well formulated, could be built up from the simple set; a particularly important point in terms of access to data for analytical and presentation purposes.

The final two categories may be taken as 'background activities' in the sense that man has little, if any, influence on the outcomes. These are:

(vii) Natural Activity (Climate and Geo-Physical Events);

(viii) Population Dynamics.

Generation of waste residuals is the source of stress usually associated with environmental pollution, although not all wastes are pollutants, nor, for that matter, do all pollutants originate from waste disposal. Stressors from this activity can be defined as the 'unwanted matter' originating from the process of transformation of materials (production) and the process of consumption. Pollution abatement activity does not reduce the quantity of wastes (except in the case of recycling), but, rather, changes the form.

Permanent environmental restructuring activities are associated with a class of stressors that result from a permanent transformation of the environment, in particular, the adaptation (restructuring) of natural ecosystems. The environmental impact assessment of major construction projects, the expansion of urbanization, the growth of transport networks, are the major focuses of this group of statistics. Nevertheless, other kinds of permanent environmental restructuring should also be included, such as the expansion of agriculture, drainage of wetlands, and reforestation. It should be noted that an important countervailing response to these stresses is the conservation and protection policies for highly-valued natural areas, landscapes, and designation of national parks.

Harvesting activity is the class of environmental stressors originating from man's ever-increasing demand for food, fibre and wood. Stresses occur when the exploitation of these resources is greater than their carrying capacity measured by their natural rate of regeneration. Indeed, the externalities due to the application of new technologies, introduction of hybrid species, and economic (or market) pressures that change the scale and nature of harvesting activities need also to be captured by the appropriate statistics. There is increasing concern in this field as a result of the worldwide need to improve food production.

Extraction of non-renewable resources results in a set of stressors which are in essence 'potential' rather than 'actual'. This is because they are concerned with the rate of extraction in terms of known (or anticipated) supply. Conceptual basis of a stressor measure of this class is the impact on the environment of exploiting increasingly low-grade sources, or of alternative actions required to substitute the exhausted supply. This is reflected directly in terms of the additional energy and infrastructure required to exploit increasingly low-grade deposits, the

exploration costs of finding alternative supplies, the effect of recycling activity, and the impact of synthetic substitutes. It should be noted that stress by the activity of extraction (mining) is included in categories (i) and (ii).

Production and consumption of potentially hazardous substances are essentially subsets of the stressors in (i), (ii) and (iii), but because of their special nature and their current topicality, it was considered useful to separate them out for special treatment. This class of stressors has been recognized quite explicitly in the various national and international efforts to control their production and consumption. The serious concern of environmental contamination provides strong incentive to give priority for the development of this part of the framework. The distinction can be made between contaminants that are a result of application of chemical aids, such as for cultivation of crops, from those that enter the environment through accidental spills or effluent discharges.

Energy production and consumption are the sources of a large number of stressors on the environment. Of major concern today are the environmental impacts of the different techniques for organizing energy in a usable form (production), the environmental impact of energy networks and exploration, and development of fossil fuel extraction in ecologically sensitive areas, e.g. sea bed, arctic, etc. On the consumption side are the potential environmental stresses of the expansion of high-energy technology, of which the most pervasive is the use of the private automobile. On the whole, statistics on energy are well developed and, in some respects, the framework merely suggests a form of organizing these data for assessing the state of the environment.

Natural activity stressors are essentially the 'deterministic forces' of the state of the environment whereby all life in its myriad forms must adapt. Meteorological records are fundamental descriptions of the state of the environment and thus form a background variable in the assessment. Of major concern are the impacts of extreme conditions (those that are far above or below the normal range). Thus, of interest are statistics which show the influence of climate on additional fuel consumption due to a particularly severe winter, or the loss of crops due to prolonged drought. Another concern would be long-term trends in change of climate.

Population dynamics are influenced both by natural and human activity. In its broadest aspect, it includes in the spatial context, expansion and contraction of the populations' habitats, and, in the temporal context, the growth and decline of natural populations. Statistics in this area, when dealing with human population, are available from Census and Vital Statistics. The framework suggests new dimensions in demography for the purpose of environmental assessment. For the other 'species', detailed statistical documentation is not readily available. Nevertheless, there is an increasing interest in this field, and the development of "ecological mapping" promises a potential methodology for keeping records of natural populations and their habitats.

Data Base	Data Series	Environmental Dimension
Census (population)	Growth, Distribution (Density), Migration	Rural-Urban, River Basin, Biome (i.e. climate-soil-physical features).
Health Statistics	Mortality rates Morbidity rates	Sickness and death rates from diseases where exposure to stressful environment is considered a key factor. Reported incidence of contaminant poisoning - e.g. insecticide spraying, food poisoning.
Housing Statistics (Census and Special Surveys)	Individuals per dwelling unit, facilities by dwelling unit. Dwelling type, e.g. single detached, apartment, high rise, etc.	Crowding index. Facilities per household. Shift in dwelling type.
Household Surveys	Income and Expenditure surveys. Asset surveys	Environmentally directed expenditure - travel, recreation. Ownership of high environment impact goods - cars, 2nd homes, motorised recreation equipment.
Special Surveys	Ad-hoc surveys of special interest	Perception and attitudinal surveys regarding environment. Recreational use of natural resources. Travel habits, commuting and holiday.

Data Base	Data Series	Environmental Dimension
System of National Accounts	Production and Expenditure Accounts	Aggregate estimates of 'externalities'
Manufacturing Statistics	Inputs and Outputs	- production of hazardous substances; - inputs of chemicals, fuels, electricity; - expenditure on pollution abatement equipment; - process type; - recycling activity; - water, inflow-outflow
Mining	Inputs and Outputs	same as above
Agriculture (Census and Surveys)	- Land Use	- area used for crops, livestock, wood lots, orchards, etc. - area irrigated, improved, fertilised, etc.;
	- Stock	- number and type of livestock, machinery;
	- Input-Output	- production of food, fibres, etc. - inputs - fuel, electricity, fertilisers, pesticides, etc.
Forestry	- Land Use	Area and type of forests
	- Stock	- volume of timber; - heavy machinery stock;
	Input-Output	- quantity of wood cut; - inputs - energy, pesticides, etc.
	Forestry Balance	Regeneration rates, loss due to forest fires, disease and cut-over.

Data Base	Statistical Series	Environmental Dimension
Fishing	- Stock	- estimates of available by type of fish; - number and types of fishing vessels;
	Input-Output	- fish catch; - fuel consumption; - cost per unit output
Transport	- Stock	- network of transport system; - stock of equipment;
	Input-Output	- movement of goods and people; - fuel consumption
Trade Statistics	Imports and Exports	- imports of hazardous substances; - imports of energy, e.g. fuels, electricity; - exports of energy, e.g. fuels, electricity; - exports of goods from high environmental impact industries;
	Wholesale and Retail	- sales of hazardous substances, e.g. fertilisers, pesticides, chemicals; - sales of high environment impact goods, e.g. cars, detergents
Service Statistics	Input-Output	- fuels for heating, e.g. office buildings; - waste disposal services
Government Statistics	Expenditure	- environmental management; - water purification and waste treatment facilities;
	Facilities	- waste treatment facilities by type, e.g. primary, secondary, tertiary; - government monitoring facilities for air and water.

Appendix 1: Environmentally Relevant Statistical Series from the Demographic and Socioeconomic Data Base.

Activity	Stressors Statistics	Stress Statistics	Environmental Response Statistics	Collective and Individual Response	Inventory of Stock Statistics
I Generation of Waste Residuals	From i. Industry - Primary - Secondary - Tertiary ii. Households iii. Municipalities	i. Pollution loadings spatially identified - air, water, land. ii. Contamination (See V).	i. Monitoring records of concentrations of pollutants in air, water and land. ii. Mortality and Morbidity records of human health iii. Monitoring of 'health' of biological species	Curative Measures - Private Expenditures and installation of pollution abatement equipment - Public expenditure and installation of waste treatment and purification plants. - Cost of env. clean-up Preventive Measures - Public and Private investment in less env harmful processes. - Recycling of waste materials	i. Capacity of - pollution abatement equipment - water waste treatment and purification plants - recycling plants ii. Solid waste disposal sites.
II Permanent Environmental Restructuring	i. Major Construction Activity in - Transport networks, - Energy networks, - Water storage and irrigation networks, - Urban expansion ii. Change in land use - Urbanization - Agriculture - Forestry - Recreation	i. Local impact measures of infrastructure stressors - change in water regimes - access roads to wilderness - tourist and recreational development	i. Measures of ecosystem change ii. Loss of productive lands iii. aesthetic impact of environmental restructuring iv. erosion, sedimentation	i. Protective and conservation Policy measures - national parks, - wildlife refuge ii. restriction of tourist development iii. ecosystem rehabilitation iv. expenditure to minimize adverse impact of env. restructuring activities.	i. Stock of man-made infrastructure ii. Inventory of protected areas - National Parks, Wildlife refuge
III Harvesting Activity	i. Production from Renewable Resources - food - fibre - wood ii. Introduction and spread of new technology	i. specific (biome) stressors ii. Technological Stress - fertilizer, pesticide application - monoculture, feed lots, - introduction of exotic species - Elimination of "undesired" species	i. Changes in the rate sustainable yield ii. measurement of soil productivity, iii. other env. impacts - erosion - abandonment of marginal farmlands - salination	i. Control of the use of technology - restrictions on pesticide use - Quota or rationing of harvests - Expenditure on management of renewable resources	i. Stock of renewable resources - Agricultural land by degree of productivity, - Forest lands - Fishing stock - Wildlife stock - Stock of domestic animals - Food stock

Appendix 2: Examples of Statistical Data Sets for the S-FESS.

Activity	Stressors Statistics	Stress Statistics	Environmental Response Statistics	Collective and Individual Response	Inventory of Stock Statistics
IV Extraction of Non-Renewable Resource	i. Rate of (scarce) non-renewable resource in relationship to available supply ii. Rate of growth of substitutes iii. The marginal energy use, and cost, per unit of output	same as I and II	same as I and II	i. Restrictive and control measures of non-renewable resources ii. substitution response	i. Stock of non-renewable resources - minerals - fossil fuels
V Production and Consumption of Potentially Hazardous Substances	i. Production and use of P.H.S. (Commodity Balance) ii. Transportation of P.H.S. iii. Disposal of P.H.S. (include nuclear fuels)	i. leakage and spillage of P.H.S. ii.. Application of Fertilizers, Pesticides etc. iii. Use of food preservatives and additives iv. Radiation levels (man originated)	i. Concentration of contaminents in environmental media ii. Contaminents in drinking water iii. Contaminents in biological species iv. Incidence of contaminent poisoning and carcinogentic exposure in man	i. list of controlled and restricted chemicals ii. cost of management of control programme iii. cost of safety measures in Industry and Government iv. Cost of clean up of "spillage"	i. Stock of P.H.S. ii. Capacity and location of potentially dangerous sources of P.H.S - Nuclear plants - Chemical plants
VI Production and Consumption of Energy	i. Energy Production ii. Energy Consumption iii. Supporting Infrastructures - generation - distribution	i. Thermal Pollution loadings ii. Noise generation (acoustic energy) iii. Emissions of pollutants from fossil fuels	i. Temperature Change in aquatic systems ii. Nuisance and health stresses on humans iii. Concentration of energy source pollutants in env. media	i. Energy Conservation Measures - (performance and costs). ii. Shift in energy use iii. Shift from high to low energy technology	i. Stock of energy resources - fossil fuels - hydro potential ii. Capacity of energy production - Hydro - Nuclear - Fossil
VII Natural Activity	i. Meteorology Records ii. Geo-physical events iii. Long term climate changes	i. Extreme variations in climate (above and below normal range local variations ii. Geo-physical events location specific	i. Harvest variations ii. Long term changes in "biome" due to climate change iii. Floods, earthquakes, droughts etc.	i. Expenditure and other responses to combat extreme weather conditions and geo-physical events.	i. Mapping of the natural world - Ecological mapping - mapping of "high probability" of geo-physical event - mapping of climate zones.
VIII Population Dynamics	i. Growth and decline of Populations - human - animal - plant ii. Expansion and Contraction of habitats - human - animal - plant	i. Overpopulation - human - animal - undesired plant species ii. Spatial movement of population - into uninhabited	i. Demand on natural resources - land water, renewable and non-renewable ii. Mortality, Fertility, and Morbidity	i. Control of Habitat Expansion ii. Control of population size	i. Population Counts - people - wildlife ii. Mapping of Habitats - Human settlements - Wildlife habitats

Appendix 2: Examples of Statistical Data Sets for the S-RESS

ECOLOGICAL-TYPE ACTIVITIES, DEPARTMENT OF ENERGY, MINES AND RESOURCES*

R. J. Fulton
Geological Survey of Canada
Ottawa, Ontario

Terrain Sciences Division of the Geological Survey of Canada is the group in the Department of Energy, Mines and Resources that has been doing work that might be referred to as "Ecological Land Classification Activities". As stated at Petawawa (Fulton, 1976), Terrain Sciences Division is concerned largely with geomorphologic and geologic aspects of the country and only in northern areas, where vegetation can play a large role in conditioning physical processes, are the vegetation aspects considered.

The only place where 'ecological' activities have been carried out since 1976 is in the Arctic (Figure 1). There, Hodgson and Edlund covered King Christian, Cornwall, Amund Ringnes and part of Ellef Ringnes Islands and will shortly be completing maps and extended legends of the same general type as those for central Ellesmere Island (Hodgson, 1977; Hodgson and Edlund, 1975 and 1978). Also Thomas, Dyke, Edlund and Tarnocai mapped an area in north-central Keewatin while Vincent and Edlund covered Banks Island (Edlund, 1977; Tarnocai, 1977: Thomas, 1977).'Ecological' maps have also been recently released for Bathurst, Cornwallis and adjacent islands (Barnett, Edlund and Dredge, 1977a and b). This work used the system that was described by Barnett, Edlund and Dredge (1977c) and was used for similar work in eastern Melville Island (Barnett, Edlund and Dredge, 1975). Ecological data at 1:250,000 scale was put together for Terrain Sciences Division by Geo-Analysis Ltd. (Geo-Analysis, 1977) for the proposed ALCAN pipeline route across the Yukon. This was meant to provide an overview of the proposed route to indicate where sensitive areas lay, where there were data gaps, and which areas and problems required further work.

Specific use of this information is difficult to document. The ALCAN pipeline overview was used as an aid in planning our own work along the proposed route but was also meant to provide the Environmental Social Program - Northern Pipelines (ESP-NP) with a general view of problems and a catalogue of available information. The King Christian-Ringnes Islands work and that on the Parry Islands and mainland were also meant to fill requirements for data that might in the future be needed by ESP-NP, in this case to assess a pipeline application. This information and that for Banks Island has also been oriented towards providing Indian and Northern Affairs with information that they can use in evaluating land use permit applications but it is not known whether they have used it. We do know that consultants involved in preparing the Polargas pipeline application and in port and harbour studies have used our information and maintain a continued interest in our releasing additional information.

The question might be asked whether our work in the north should be classified as "Ecological" mapping. Our treatment of data has not always been the same but, in general, we rely on a map based on geological-geomorphological units, with a legend that indicates the types of vegetation and soils found within each general map-unit. Our vegetation and soils information is highly generalized and with the exception of the Melville-Bathurst-Cornwallis work it does not influence the position of any of the map-unit boundaries. It has however been possible to supply Canadian Wildlife Service with habitat information and to recast the terrain maps into vegetation maps.

We do not look at our work as something that will supply answers to all the questions that might be asked. We feel that in a cost-effective way it provides an understanding of the ecologic-geologic relationships of an area. In other words it is not meant to supply site specific detail for all areas but to set up a general framework that can be used in extrapolation and through which the meaning of site specific data can be interpreted.

*Abstract/Résumé on/à page 129.

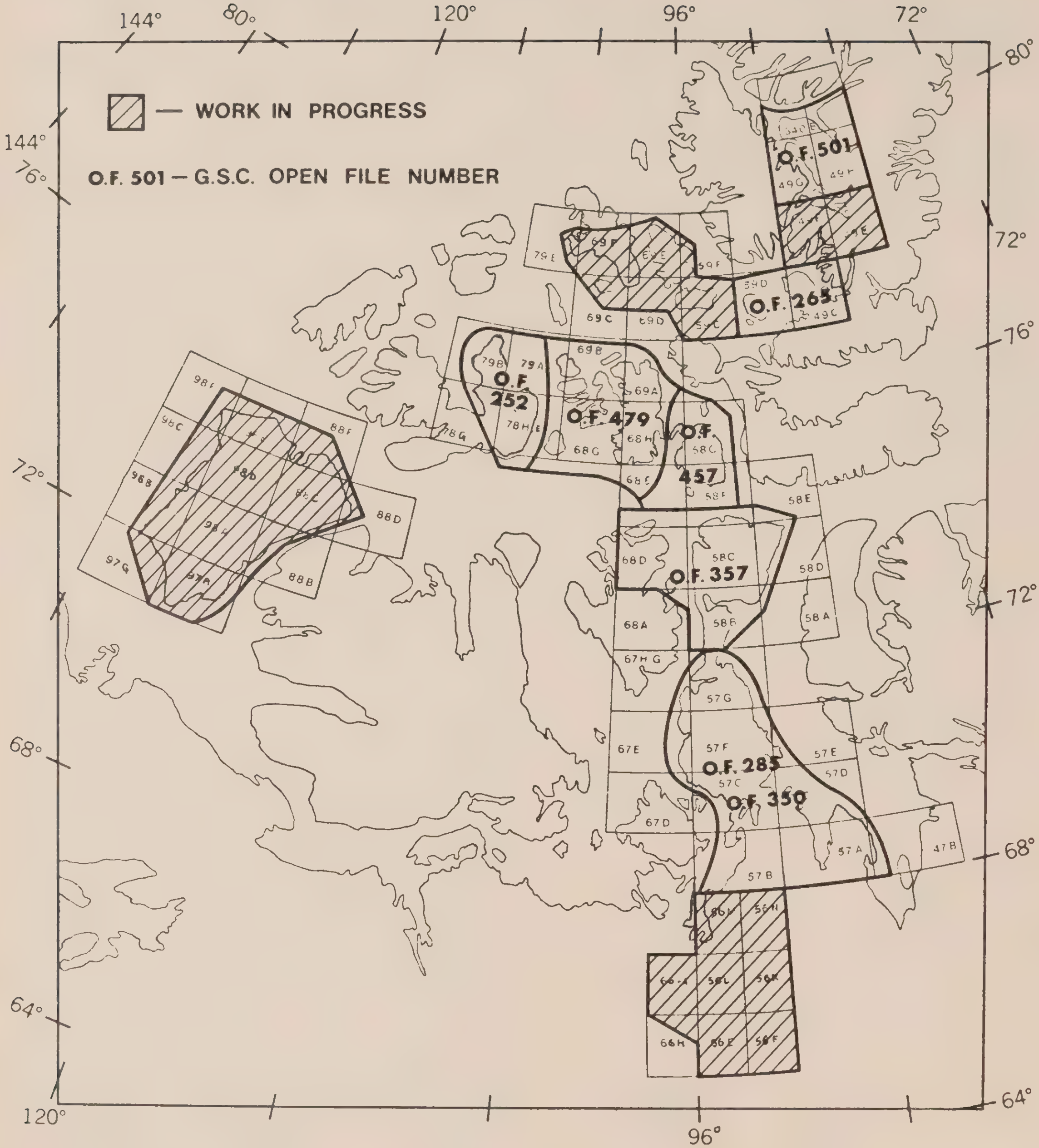


Figure 1: 'Ecological' Land Classification Projects of the Terrain Sciences Division, EMR.

REFERENCES

Barnett, D.M., S.A. Edlund and L.A. Dredge. 1975. Terrain classification and evaluation-Eastern Melville Island, N.W.T. Geol. Surv. Can. Open File 252.

Barnett, D.M., S.A. Edlund and L.A. Dredge. 1977a. Terrain characteristics-Cornwallis and adjacent islands, N.W.T. Geol. Surv. Can. Open File 457.

Barnett, D.M., S.A. Edlund and L.A. Dredge 1977b. Terrain characteristics - Bathurst and adjacent islands, N.W.T. Geol. Surv. Can. Open File 479.

Barnett, D.M., S.A. Edlund and L.A. Dredge. 1977c. Terrain characterization and evaluations: An example from eastern Melville Island. Geol. Surv. Can. Paper 76-23, 18 p.

Edlund, S.A. 1977. Vegetation types of north-central District of Keewatin. Geol. Surv. Can. Paper 77-1A, pp. 385-386.

Fulton, R.J. 1976. Biophysical-type surveys in the Department of Energy, Mines and Resources, *in* Proc. First Meeting Can. Comm. Ecol. Land Classif., Ecological Land Classification Series No.1 pp. 49. Lands Directorate, Environment Canada, Ottawa.

Geo-Analysis Ltd. 1977. Terrain overview along ALCAN pipeline route. Geol. Surv. Can. Open File 448.

Hodgson, D.A. 1977. The terrain mapping and evaluation system adopted for the eastern Queen Elizabeth Islands. Geol. Surv. Can. Paper 75-1C, pp. 95-100.

Hodgson, D.A. and S.A. Edlund. 1975. Surficial materials and biophysical regions, eastern Queen Elizabeth Islands: Part I. Geol. Surv. Can. Open File 265.

Hodgson, D.A. and S.A. Edlund, 1978. Surficial materials and biophysical regions, eastern Queen Elizabeth Islands: Part II. Geol. Surv. Can. Open File 501.

Tarnocai, C. 1977. Soils of north-central Keewatin. Geol. Surv. Can. Paper 77-1A, pp. 61-64.

Thomas, R.D. 1977. A brief description of the surficial materials of north-central Keewatin, N.W.T. Geol. Surv. Can. Paper 77-1B, pp. 315-317.

ABSTRACT

Work done by the Department of Energy, Mines and Resources that might be classed as ecological mapping has been biased heavily towards the geological-geonorphological end of the ecological unit spectrum. This paper lists work of this type that has been published by the Geological Survey of Canada and outlines areas where additional work has been carried out since 1976. (Ed. Abstr.)

RÉSUMÉ

Les travaux réalisés par le ministère de l'Energie, des mines et des ressources et qui peuvent être classés dans le domaine de la cartographie écologique se sont avérés nettement axés sur l'aspect géologique et géomorphologique de l'étude. Le présent rapport énumère les réalisations de la Commission Géologique du Canada et souligne les domaines où des travaux supplémentaires ont été effectués depuis 1976. (Rés. Éd.)

RECENT ECOLOGICAL LAND CLASSIFICATION ACTIVITIES OF THE CANADIAN WILDLIFE SERVICE

G. H. Watson
Canadian Wildlife Service
Environment Canada
Ottawa, Ontario

The Canadian Wildlife Service (CWS) has used various ecological land classification systems for many years in order to evaluate wildlife habitat.

During the summer of 1977, CWS was involved in a program of habitat assessment along the proposed "ALCAN" pipeline route. Waterfowl population surveys and habitat evaluations were conducted within a 6.4 km wide corridor between Watson Lake and Beaver Creek. At the same time, the Yukon territorial government did surveys of ungulates, fur-bearers, raptors and game birds and their habitat.

For the last three years, CWS has worked on ecological land classification in Jasper and Banff National Parks. A typical example is the study of the use of forage by ungulates (elk, deer, moose and bighorn sheep) on ecological land systems along the Bow Valley. This study has been commissioned by Parks Canada and is undertaken in cooperation with the Warden Services of the Parks Branch.

In Ontario, CWS undertook two ecological land classification projects in the Rideau section of the Canada-Ontario Rideau Trent Severn (CORTS) Corridor and in the Hudson Bay Lowland. The CORTS study was done in conjunction with the Lands Directorate, Ontario Region, Environment Canada. The primary clients are CORTS, Parks Canada and CWS. Secondary clients who have expressed a keen interest are the conservation authorities, the Ontario Ministry of Natural Resources, and private environmental groups.

Other ecological land classification work was done by the Lands Directorate between the Ontario-Quebec border and the Albany River of southwestern James Bay. The primary client for this program is CWS. Its objective is to establish base-line data of the present condition of this natural environment and to determine the dynamics and principal processes operating within the ecosystems of the region.

Prior to the field season, preliminary maps based on satellite imagery and aerial photographs were prepared to show landforms, drainage and vegetation patterns. Summer field work involved ground truthing as well as collection of sedimentological, botanical and water chemistry data. Detailed information on the distribution and habitat requirements on invertebrates, migratory shorebirds and waterfowl were also gathered. CWS biologists, working one year after the ecological classification team, will critically examine the land units mapped in comparison to observed bird utilization this summer.

BACKGROUND PAPERS ON APPLICATIONS OF ECOLOGICAL LAND CLASSIFICATION IN CANADA

ÉTUDES DE FOND SUR LES APPLICATIONS DE LA CLASSIFICATION ÉCOLOGIQUE DU TERRITOIRE AU CANADA

APPLICATIONS OF ECOLOGICAL LAND CLASSIFICATION: A USER SURVEY

C. D. Rubec
CCELC Secretariat
Ottawa, Ontario

ABSTRACT

A brief questionnaire, distributed to potential and current users of ecological land classification, has provided an overview of application problems and benefits associated with ecological survey in Canada. Responses were received from a wide variety of federal, provincial and corporate agencies. The need for extensive user training at all levels and the need for in depth analysis of benefit/costs of these projects are emphasized.

RÉSUMÉ

Un questionnaire bref, distribué aux usagers réels et prévisibles de la classification écologique du territoire, a permis la revision des applications, des problèmes et des bénéfices relatifs au relevé écologique au Canada. Un grand nombre d'agences féderales et provinciales ainsi que des corporations ont répondu à ce questionnaire. Il en résulte la mise d'une attention spéciale sur le besoin d'une plus ample instruction à l'intention des usagers à tous les niveaux ainsi que sur le besoin d'une analyse en profondeur des bénéfices/coûts de ces projets.

INTRODUCTION

In its first year of activity the CCELC has kept abreast of new land classification projects and is now considering the potential for applications of the data generated by such surveys. The CCELC Secretariat felt it would be useful to identify definite ELC applications by direct contact with users throughout the country. Responses to a short questionnaire distributed by the author are described in this paper.

A questionnaire and covering letter requesting information on current applications of ecological land classification information was sent to about 640 persons or agencies who have expressed interest in the CCELC Applications Working Group. The questionnaire was also distributed to 160 environmental consulting companies listed in Canadian telephone directories. Each agency was requested to list objectives of their application; a description of the project; benefits and problems observed during the project; and the name, affiliation and address of the principal investigators involved.

A total of 61 responses were received from federal and government departments, universities, consulting companies, conservation authorities, timber companies and corporations such as Hydro-Quebec, Polar Gas and Ontario Hydro. Table 1 provides a breakdown of the sources of these responses. The quality and topics of these responses varies widely. While the questionnaire invited short replies, many agencies took the time to prepare detailed replies with supporting documents. Frequently, more than one ecologically oriented project was described.

A breakdown of the major topic areas, dealt with in the 92 projects described in responses, is made on Table 2. It is evident that some groups were either confused about the desired information or are not as conversant with ecological land classification as they could be. Several projects which are reported do represent attempts to gather specific ecological information but only a few deal with precise applications of ELC integrated data. Some agencies took the opportunity to advertise their expertise but did not provide any direct information. Examples of excellent applications of Canada Land Inventory data were forwarded as well. Reports of projects where ecological data have been applied include: (1) Highway and road arterial location; (2) Ski lift construction; (3) Wildlife habitat inventory; (4) Park and recreation land surveys; (5)

Table 1: Sources of CCELC Survey Responses

Federal Departments	9
Provincial Departments or Agencies	13
Universities	12
Consultants	20
Corporations and others	7
TOTAL	61

Table 2: Nature of Responses to CCELC User Survey

1.	Development Studies for Ski Lift and Highway Construction Projects	8
2.	Wildlife Inventory and Habitat Mapping	6
3.	Vegetation Mapping, Park Surveys, Forestry Productivity and Inventory	16
4.	Specific Ecological Land Classification Projects	7
5.	Shoreline and Lake Classification, Fish Productivity Inventory	5
6.	Land Classification System Development	2
7.	CLI Applications, Critical Lands Identification	3
8.	Urban Development	14
9.	Mine and Mill Site Impact Assessment	8
10.	Hydro Reservoir or Line Corridor Surveys and Development Studies	11
11.	Oil Pipeline Routing Surveys and Development Studies	7
12.	Ecological Land Classification Teaching Related	2
13.	Indian Reserve Studies	3
	TOTAL	92

Forest productivity and land management; (6) Coastal, shoreline, watershed and fisheries management; (7) Urban subdivision planning; (8) Mine and mill site impact assessment; (9) Hydro reservoir and corridor planning; (10) Oil pipeline and exploration studies; (11) Environmental surveys of Indian Reserves.

USER IDENTIFIED BENEFITS FROM ELC SURVEYS

Universally, each respondent has identified benefits accrued by ELC survey both in practical and financial terms. The survey did not however, solicit in-depth outlines of costs and precise dollar savings. A true benefit/cost analysis would be most desireable providing some standardization of the inputs of these calculations if possible. User comments are confidentially listed here in point form:

- ELC data allow consideration of environmental factors at the feasibility stage without requiring costly studies of all the alternatives.
- ELC data allow savings of time and expenses.
- ELC allows rapid, cost effective evaluation of critical environmental implications for development.
- A framework to direct and catalogue future ecological work is provided by ELC surveys.
- The use of the quantitative method in ELC is better received by planning boards than subjective opinions.
- Ecological data bases allow testing and modification of more than one design.
- A sound basis for site design, management recommendations and predicted impacts is possible with an ELC data base.
- Ecological data provide a framework relating to resources and land use information. Hence, land units (systems, types) become management units.
- Road network design, alignment and grading are improved by intial ELC data.
- ELC allows earlier input of surface terrain and geotechnical data into urban planning functions avoiding expensive excavation, design and foundation problems. An example would be construction of low rise versus high rise buildings where the latter is unsuited. An ELC data base is seen as highly useful to urban design functions.
- ELC data enhances agricultural land and allows stabilization of waterfowl areas in reservoir planning.
- Linking of ELC data and capability data leads to more accurate forest productivity calculations and more accurate estimation of silviculture costs by identifing viable timber areas.
- Identification of Natural Areas in SW Ontario has led to some protection of environmental features; has encouraged environmental assessment and has increased awareness of environmental planning.
- ELC prior to urban development in Alberta excluded low potential land from land banks; identified inappropriate land use proposals; and led to recommendations of change in some current uses on specific sites.
- ELC prevented excessive landscape damage in northeastern BC on permafrost terrain during corridor construction.
- ELC on Indian Reserves is seen as a tool for giving native leaders a better perspective of reserve lands vis-a-vis their desires to preserve resources for future generations.
- ELC provides a suitable framework for all types of development and resources management.
- ELC may minimize flooding damage and wildlife habitat disruption in reservoir management.

USER IDENTIFIED PROBLEMS WITH ELC SURVEYS

In their responses, users have identified numerous problems encountered during ELC projects or with the information produced. Misunderstanding of the ELC approach is observed at all levels from the collectors of the data, through project planners and managers, to the funding agencies themselves. The more interesting responses again on a confidential basis, are outlined in point form:

- At times too much detailed information is available at too large a scale.
- Quantified data runs the risk of being relied upon as "absolute" rather than as a guideline.
- The raw data generated by ELC surveys must be integrated from the onset since alone they are often incomprehensible to potential users.
- Some ecological parameters end up being mapped as units much more complicated and smaller than for other parameters making it difficult to map discrete units integrated for all factors.
- Ecological data is often of limited availability making it inaccessible to some users.
- Creating ecological data bases often depends on several sources of varying detail and quality.
- The ELC approach is often not understood by clients.
- Convincing engineers, in advance of construction that some problems can be anticipated if ELC is properly used, is a difficult task.

- Existing ELC documents in BC are often not a suitable substitute for on-site engineering in areas of urban expansion.
- ELC results in greater expenditure of public funds and higher costs to consumers in relation to gas line routing studies.
- Planners, being steeped in routine approaches are often skeptical and non-appreciative of ELC.
- Logistically the best time for ELC studies is coincidental with engineering schedules; hence the time and efficiency of response to environmental protection is jeopardized.
- Exhaustive ecological inventory is insufficient. An analysis period for resources capability and sensitivity assessment is required as well.
- Computerized land data systems are restricted by the lack of understanding by planners of the complex methodology involved. Hence, computers are often mistrusted or misused.
- Indecision is often a serious handicap as political and administrative implications often take precedence over ecological ones.
- Staff training is required for optimal use of ecological information. Staff shortages create serious problems in implementing recommendations as well.
- The ability to hold onto staff and funding for extended periods makes ecological monitoring/classification impossible for periods over several years in length.
- ELC projects are hampered by unsupportive legislation in many cases.
- Vast amounts of field work often outweigh the benefits from ecological surveys.
- The allocation of planning functions to levels in a hierarchy is difficult.
- In urban areas the mere existence of ecological feasibility studies will create land speculation.
- Cartographic representation of natural features on interpretive maps appears to require greater standardization.
- Generalized ELC data for large areas provides insufficient data.

SUMMARY

It is clear that increased awareness of the value and, frequently, availability of ecological land classification data is needed. This survey suggests that while an integrated ecological approach to planning and management is gaining acceptance, only a limited number of government or corporate agencies have identified their needs for ELC information as yet. No attempt to comment on the logic or verify opinions of the respondents to this survey is made. A more exhaustive survey of detailed cost/benefits from these projects would be desireable.

APPLICATIONS DE LA CLASSIFICATION ÉCOLOGIQUE DU TERRITOIRE: UNE ENQUÊTE AUPRÈS DES UTILISATEURS

C. D. Rubec
Secrétariat du CCCET
Ottawa, Ontario

RÉSUMÉ

Un questionnaire bref, distribué aux usagers réels et prévisibles de la classification écologique du territoire, a permis la revision des applications, des problèmes et des bénéfices relatifs au relevé écologique au Canada. Un grand nombre d'agences féderales et provinciales ainsi que des corporations ont répondu à ce questionnaire. Il en résulte la mise d'une attention spéciale sur le besoin d'une plus ample instruction à l'intention des usagers à tous les niveaux ainsi que sur le besoin d'une analyse en profondeur des bénéfices/coûts de ces projets.

ABSTRACT

A brief questionnaire, distributed to potential and current users of ecological land classification, has provided an overview of application problems and benefits associated with ecological survey in Canada. Responses were received from a wide variety of federal, provincial and corporate agencies. The need for extensive user training at all levels and the need for in depth analysis of benefit/costs of these projects are emphasized.

INTRODUCTION

Durant sa première année d'activité, le Comité Canadien de la Classification Écologique du Territoire (CCCET) s'est tenu au courant des nouveaux projets de classification des terres et il envisage actuellement d'étudier les applications des renseignements recueillis au cours de ces enquêtes. Le secrétariat du CCCET a jugé utile de chercher à identifier les applications précises d'une classification écologique du territoire (CET) au moyen d'une approche directe de ceux qui l'utilisent à travers le pays. Dans ce bulletin, on trouvera le détail des réponses à un court questionnaire qui a été diffusé par l'auteur. Un questionnaire, auquel était jointe une lettre d'accompagnement demandant des renseignements sur les applications actuelles de la documentation se rapportant à la classifiction écologique du territoire, a été envoyé à près de 640 personnes ou organismes qui avaient manifesté de l'intérêt à l'égard du groupe de travail sur les applications du CCCET. Ce questionnaire a également été distribué auprès de 160 sociétés d'experts en matière d'environnement répertoriées dans les annuaires téléphoniques du Canada. Chaque organisme était prié d'indiquer les objectifs de son application propre, de donner une description du projet envisagé et de citer les avantages et problèmes rencontrés durant sa mise en oeuvre, ainsi que le nom, l'affiliation et l'adresse des principaux enquêteurs engagés dans l'opération.

Soixante et une réponses ont été reçues au total; celles-ci provenaient des ministères fédéraux et provinciaux, des universités, des sociétés-conseils, des organismes mandatés à la préservation de l'environnement, des entreprises de bois et de compagnies telles que l'Hydro-Québec, Polar Gas et Ontario Hydro. Le tableau 1 donne la ventilation des sources des réponses reçues. La qualité de ces réponses et les sujets qu'elles couvrent se signalent par une grande diversité. Alors que le questionnaire invitait les répondants à s'exprimer avec concision, de nombreux organismes ont pris la peine de détailler leurs réponses en les soutenant par des documents. Souvent plus d'un projet à orientation écologique était décrit.

Le tableau 2 présente la ventilation des principaux sujets traités dans les 92 projets que détaillent les réponses. De toute évidence, certains groupes se sont trompés sur l'objet des renseignements demandés, ou bien n'étaient pas aussi familiarisés qu'ils auraient pu l'être avec la classification écologique du territoire. Plusieurs projets

Tableau 1: Sources des Réponses à l'Enquête du CCCET

Ministères fédéraux	9
Ministères ou organismes provinciaux	13
Universités	12
Sociétés-conseils	20
Grandes entreprises, et autres	7
TOTAL	61

Tableau 2: Nature des Réponses à l'Enquête du CCCET

1.	Études d'élaboration de projets pour remonte-pentes de ski et construction d'autoroutes.	8
2.	Inventaire de la faune et cartographie de son habitat.	6
3.	Cartographie de la végétation, enquêtes sur les parcs, productivité forestière et inventaire des forêts.	16
4.	Projets spécifiques de classification écologique du territoire	7
5.	Classification des régions côtières et des lacs, inventaire de la productivité piscicole.	5
6.	Élaboration de système de classification des terres.	2
7.	Identification des terres critiques et applications de cette identification	3
8.	Développement urbain.	14
9.	Évaluation des incidences de l'emplacement des mines et usines.	8
10.	Enquête sur les bassins de retenue des eaux et les voies de passage des canalisations et études d'aménagement associées.	11
11.	Enquête sur le tracé des oléoducs et études d'aménagement associées.	7
12.	La classification écologique du territoire dans l'enseignement.	2
13.	Études portant sur les réserves indiennes.	3
	TOTAL	92

rapportés expriment des tentatives réelles d'amasser de l'information écologique spécifique, mais il en est peu qui traitent avec précision des manières d'appliquer les données intégrées de la CET. Certains organismes ont saisi l'occasion de faire de la publicité pour leurs connaissances techniques, sans fournir toutefois le moindre renseignement pertinent.. D'autres, par contre, nous ont soumis des exemples attestant l'excellente mise en application des données de l'Inventaire des terres du Canada. Les projets où des données écologiques ont été appliquées traitent des questions suivantes: (1) l'emplacement des grandes voies de communication et des autoroutes; (2) la construction des remonte-pentes de ski; (3) l'inventaire de l'habitat de la faune; (4) les levés topographiques des parcs et lieux de loisir; (5) la productivité forestière et la gestion des sols; (6) l'aménagement des côtes, de la configuration du littoral, des bassins hydrographiques et les pêcheries; (7) la planification des subdivisions urbaines; (8) l'évaluation des incidences de l'emplacement des mines et usines; (9) la planification des bassins de retenue des eaux et des voies de passage pour les canalisations; (10) les oléoducs et les travaux de prospection pétrolière; (11) les enquêtes portant sur l'environnement des réserves indiennes.

AVANTAGES TIRÉS DES ENQUÊTES DE LA CET RECONNUS PAR LES UTILISATEURS

Tous les répondants, sans exception, ont reconnu qu'ils ont tiré des avantages de la CET sous l'angle pratique autant que financier. Cette enquête, cependant, n'avait pas cherché à connaître le détail des coûts engagés, ni le montant précis des économies réalisées. Une vériatable analyse de rentabilité serait certes bienvenue, si on parvient, autant que faire se peut, à une certaine normalisation des données d'entrée de ces calculs. On trouvera ci-dessous, détaillées point par point, les observations confidentielles des utilisateurs:

- les données de la CET permettent l'analyse des facteurs de l'environnement à la phase préliminaire, sans qu'on ait à étudier à grands frais les différentes solutions.
- ces données permettent de faire des économies de temps et de dépenses.
- la CET fournit rapidement et avantageusement (en termes de coûts) une estimation des incidences critiques du développement sur l'environnement.
- les levés du CET procurent un cadre de travail dans lequel les recherches écologiques pourront être conduites et cataloguées à l'avenir.
- les conseils de planification réservent un meilleur accueil à la méthode quantitative utilisée dans la CET qu'à la subjectivité des opinions.
- les bases des données écologiques autorisent la mise à l'épreuve et la modification de plus d'une conception.
- en se servant d'une base de données de CET, il devient possible de donner des fondements solides à la configuration d'un site, aux directives de gestion ainsi qu'à la prévision des conséquences.
- les données écologiques procurent un plan de travail qui s'applique aux ressources et aux renseignements sur l'utilisation des sols. Ainsi, les unités de sols (systèmes, types) deviennent des unités de gestion.
- les données premières de la CET permettent d'améliorer le calcul, le tracé et le terrassement d'un réseau routier.
- la CET permet d'introduire au premier stade d'un projet de planification urbaine les données géotechniques et d'étude de surface, ce qui évite les onéreux problèmes que posent l'excavation, le calcul des plans et des fondations. Ainsi, on décidera de construire des immeubles peu élévés au lieu de tours d'habitation lorsque ces dernières seront déconseillées. On considère donc qu'une base des données de CET est d'une grande utilité dans les fonctions de conception urbanistique.
- les données de la CET mettent en valeur les terrains agricoles et permettent de prévoir des zones d'oiseaux aquatiques dans la planification des bassins de retenue des eaux.
- en faisant le lien entre les données de la CET et celles des possibilités de rendement, on arrive à des calculs précis de productivité forestière et à une estimation plus juste des coûts de la sylviculture par l'identification des zones de bois viables.
- l'identification des zones naturelles dans le sud-ouest de l'Ontario a donné lieu à une certaine protection des caractéristiques de l'environnement; elle a également favorisé l'évaluation des conditions de cet environnement et a fait prendre conscience avec plus d'acuité de la notion de planification environnementale.
- en Alberta, préalablement à l'aménagement urbain, la classification écologique a fait exclure des banques de terres les lots ayant un faible potentiel économique; elle a permis de juger les propositions d'utilisation des terres et a inspiré des recommandations de changement à introduire dans certaines manières courantes d'utiliser des sites spécifiques.
- la CET a permis d'éviter que le paysage du nord-ouest de la Colombie-Britannique ne

subisse des dommages excessifs durant la construction de voies de passage dans le pergélisol.

- en l'appliquant aux réserves indiennes, on peut considérer la CET comme l'instrument qui donnera aux chefs autochtones une meilleure perspective des terres mêmes de ces réserves en réponse à leur désir de préserver leurs ressources pour les générations futures.
- la CET fournit un cadre de travail approprié pour tous les projets d'aménagement et de gestion des ressources.
- et enfin, elle peut diminuer les risques d'inondation et de destruction de l'habitat de la faune dans l'aménagement des bassins de retenue des eaux.

PROBLÈMES LIÉS AUX ENQUÊTES DE LA CET RECONNUS PAR LES UTILISATEURS

Dans leurs réponses, les utilisateurs ont identifié de nombreux problèmes qui se sont présentés au cours de projets de CET, ou en rapport avec le genre d'information obtenue. A tous les niveaux, on rencontre une incompréhension de la conception de la classification écologique, depuis les enquêteurs jusqu'aux planificateurs et responsables des projets et même aux organismes de financement. Ci-dessous, et toujours à titre confidentiel, on trouvera le détail, point par point, des réponses présentant le plus d'intérêt:

- il arrive parfois qu'on dispose d'une masse de renseignements trop détaillés s'étendant sur une trop grande échelle.
- lorsqu'on a affaire à des données quantifiées, on court le risque de s'y fier comme à des valeurs "absolues" au lieu de les considérer comme de simples lignes directrices.
- les données brutes que fournissent les levés de CET doivent dès le départ être intégrées, étant donné qu'elles sont souvent par elles-mêmes incompréhensibles aux utilisateurs en puissance.
- certains paramètres écologiques finissent par être reproduits sur les cartes d'une manière tres complexe comme des unités beaucoup plus réduites que d'autres paramètres, ce qui rend difficile la représentation sur les cartes des données par des unités discrètes intégrées pour tous les facteurs.
- les données écologiques ne sont souvent disponibles qu'à usage restreint, ce qui les rend inaccessibles à certains utilisateurs.
- la création des bases de données dépend souvent d'une multiplicité de sources d'inégale qualité et richesse.
- la méthode de la CET n'est souvent pas comrpise par les clients.
- c'est une tâche difficile que de convaincre des ingénieurs, préalablement à une mise en chantier, que certains problèmes peuvent être prévenus si l'on sait se servir de la CET.

dans le cas de la Colombie-Britannique, la documentation actuelle de la CET ne peut souvent remplacer de manière adéquate la technique de l'ingénieur sur le terrain dans les zones d'expansion urbaine.

- la classification écologique se traduit souvent par une plus grande dépense de fonds publics et revient plus chère aux consommateurs en ce qui a trait au tracé des voies d'adduction du gaz.
- constamment plongés dans leurs techniques routinières, les planificateurs sont bien souvent sceptiques à l'égard de la CET et incapables d'en apprécier la valeur.
- d'un point de vue logistique, le moment où il convient le mieux d'entreprendre une étude de CET est celui qui coincide avec le calendrier des travaux de génie; ce qui met en péril l'opportunité et l'efficacité des mesures nécessaires à la protection de l'environnement.
- un inventaire écologique exhaustif n'est pas suffisant. Il faut également prévoir une période d'analyse des possibilités des ressources et d'évaluation du degré de sensibilité.
- la valeur des systèmes informatisés de données écologiques est limitée par l'incapacité où se trouvent les planificateurs de comprendre la méthodologie complexe qu'ils impliquent; la conséquence en est qu'on se méfie des ordinateurs, ou qu'on les emploie de travers.
- l'indécision est un handicap fréquemment rencontré; elle découle, bien des fois, des incidences politiques et administratives qui prennent le pas sur les considérations écologiques.
- il est nécessaire de former le personnel si l'on veut faire le meilleur usage de l'information écologique. Le manque de personnel spécialisé peut donner lieu également à de sérieux problèmes, lorsqu'il s'agit de passer aux actes.
- cette activité est capable de mobiliser du personnel et des fonds durant des périodes prolongées, et ceci rend impossible des opérations de contrôle et de classification écologique s'étendant sur plusieurs années.
- dans nombre de cas, les projets de CET sont entravés par une législation qui ne leur apporte aucun soutien.
- la grande quantité de travaux à effectuer sur le terrain vient souvent contrebalancer les avantages retirés des levés écologiques.
- une difficulté se présente lorsqu'il s'agit

de répartir les fonctions de planification de planification au sein d'une hiérarchie.
- dans les zones urbaines, le seul fait qu'on procède à des études de faisabilité écologiques va entraîner la spéculation foncière.
- dans les cartes d'interprétation, la représentation cartographique des caracté-risques naturelles requiert apparement un degré de normalisation plus poussé.
- les données d'ensemble de la CET s'appliquant aux zones très étendues fournissent des éléments d'information insufficants.

SOMMAIRE

De toute évidence, une prise de conscience s'impose, prise de conscience d'abord de la valeur des données de la classification écologique, et, bien fréquemment, de leur accessibilité. Cette enquête fait ressortir le fait que, en dépit du terrain gagné dans les esprits par l'approche écologique intégrée des questions de planification et de gestion, le nombre des organismes gouvernementaux et des grandes entreprises qui reconnaissent qu'ils ont besoin d'être informés en ce domaine demeure encore bien réduit. Nous n'avons pas cherché à discuter l'aspect logique des réponses obtenues, ni à vérifier les opinions exprimées par les répondants. Il reste à souhaiter qu'une analyse de la rentabilité de ces projets fasse l'objet d'une étude plus exhaustive.

WILDLIFE INTERPRETATION KEYS FOR THE JAMES BAY TERRITORY ECOLOGICAL CLASSIFICATION **

R. Bergeron and J. M. Levasseur
James Bay Development Corporation
Montreal, Quebec

J. M. Mondoux
Service des Études Écologiques Régionales
Environnement Canada
Ste-Foy, Québec

ABSTRACT

In the course of its caribou, beaver, and moose inventories, the James Bay Development Corporation (JBDC) decided in January 1975 to focus surveys of other animal species in the James Bay Territory as well. This program ultimately aims at deriving formulae to measure the potential of the land for producing ten species: the hare, lynx, fox, wolf, otter, mink, muskrat, spruce grouse and willow ptarmigan. Interpretation keys developed for muskrat and willow ptarmigan are presented as examples of those developed to facilitate capability ratings.

RÉSUMÉ

Alors qu'elle procédait à l'inventaire du caribou, du castor et de l'orignal, la Société de développement de la Baie James (SDBJ) décidait en 1975 de s'intéresser aussi à d'autres espèces animales. Le nouveau programme vise à définir des formules pour mesurer les possibilités des terres pour la production de dix espèces: le lièvre, le lynx, le renard, le loup, la loutre, le vison d'Amerique, le rat musqué, le tétras des savanes et le lagopède des saules. Nous présentons, à titre d'exemples de clés mises au point pour faciliter l'établissement de la capacité celles qui concernant le rat musqué et le lagopède des saules. (Trad. Éd.)

INTRODUCTION

The general methodology consists of establishing interrelationships between studied species and some characteristics of the environment. These environmental characteristics can be determined from the ecological classification established by la Service des Études Écologique Régionales (SEER).

The program's goal could only be attained through both bibliographical research and inventories. A large number of specialized bibliographical references have thus been compiled, all relevant to the region studied (Figure 1). At the same time, the following surveys were carried out and data obtained from them:

(1) three aerial surveys for estimation of the moose population which also provided relevant data for the study of other species (MTCP*-JBDC, winters of 1972, 74 and 75);

(2) two ground exploratory surveys (JBDC, summer 1975; JBDC-SEER, end of autumn 1975);

(3) one aerial survey especially designed for this program (JBDS-SEER and MTCP, winter 1976);

(4) the ecological study of a trap line.

* MTCP-Quebec Ministry of Tourism, Hunting and Fishing.

A multivariate analysis method was designed especially for data processing. Although only a fraction of the obtained data has so far been processed, the analysis shows some interesting correlations between the presence of species under study in the program, and the ecological factors, as well as between the species themselves (Figure 2).

For example, it became increasingly apparent that moderately drained soils (mesic 3) have vegetation that is especially favoured by several animal species (cf. Figure 3). On the other hand, wetlands were shown to be extremely important for their wildlife potential. In fact the study of a trap line carried out in 1976, brought out the importance of riparian habitats. In this study, the trap lines were shown on the map of ecological types at a scale of 1:20,000. This superimposition combined with an analysis of trapping data indicated the intensive use of riparian habitats by wildlife. These habitats have been identified in terms of ecological types in a memorandum by J.M. Mondoux (1976).

The identification of the principle relationships between the species under study and the mapped ecological criteria has permitted the weighting of each of the criteria. This has served as a basis for establishing formulas to interpret wildlife potentials from the ecological inventory data. Two of these interpretation keys are provinded as examples, for muskrat, and willow ptarmigan. (English legends are appended to the tables and figures presented

in this paper to facilitate their use - ed).

INTERPRETATION FOR MUSKRAT

The "Key for Muskrat Potential" signals the debut of a new generation of interpretation keys. Unlike the interpretation keys for various fish species potentials, those for the muskrat and subsequent species do not attempt to use the greatest number of criteria possible, but only those which have the greatest influence on the species. The advantage of this is to considerably simplify the key and its application. The precision lost by this method would have disappeared in any case in the process of aggregation into classes of potential; furthermore such precision can often not be accommodated by the limited resolution capacity of the ecological map.

The criteria retained to describe the muskrat's habitat are the aquatic ecosystem categories, the surface material of the banks, and the riparian site abundance classes.

Table 1 summarizes the elements of the interpretation key in trellis form. Two scenarios of classification of potential are presented: the first illustrates the use of 6 classes while the second only illustrates the use of 3. Although the first is more precise, it probably exceeds the needs of the user. Never-the-less, it is easier to reduce the number of classes from 6 to 3, once the compilations have been carried out, than the reverse.

INTERPRETATION FOR PTARMIGAN

The interpretation of the ecological map for ptarmigan presented a new problem due to the migratory character of this species. Even though irregular, these migrations bring into the southern part of the Territory, in winter, a large number of birds which generally nest only in more northern regions. For this reason, the Ecological Regions take on a preponderant significance in the "Key for Ptarmigan Potential". The other elements retained for the derivation of this key are the aquatic system category and the abundance of riparian sites. This latter criteria has furthermore been considered with respect to the Ecological Region; the decreasing abundance of riparian sites towards the north has been taken into account in the definition of different classes of potential.

Table 2 presents the interpretation key elements in a trellis form. The derived classes of potential are shown below:

(1) Excellent - Nesting probable

(2) Good - Nesting possible

(3) Average - Nesting less possible but migration probable

(4) Poor - Migration probable

(5) Very poor - Migration possible but rare.

REFERENCES

Bergeron, R. 1975. Premières hypothèses de potentiel selon les caractéristiques de l'habitat, Environnement, Société de developpment de la Baie James.

Gingras, J. 1975. Potentiel faunique (première approximation) Environnement Société de developpement de la Baie James.

Gingras, J. 1975. Potential faunique. Rapport d'étape préliminaire, Société de developpement de la Baie James.

Levasseur, J.M., P. Lessard, P. and R. Bergeron, Proies et prédateurs de la région de Chibougamau, Environnement Société de developpement de la Baie James. (undated).

Levasseur, J.M. 1975. Rapport d'inventaire sur la loutre, le lynx, le renard et le loup (deuxième partie), Environnement, Société de developpement de la Baie James.

Levasseur, J.M. et J.M. Mondoux, 1975. Inventaire terrestre de la Faune. Société de developpement de la Baie James.

Mondoux, J.M. 1976. En référence au programme d'évaluation du potentiel. Direction Régionale des Terres. Environnement Canada. Note de Service. 5 jan. 76.

Legendre, P., F. Long, R. Bergeron, et J.M. Levasseur, 1977. Inventaire aérien de la faune dans le moyen nord québécois. Direction Environnement. Société de developpement de la Baie James.

*(** This paper has been prepared by the editor based on material circulated by the authors at the meeting. Further interpretation examples and appendices in the original have been excluded in this presentation).*

APPENDIX I

LAND SYSTEM CLASSIFICATION CRITERIA

Each land system is identified by a series of symbols such as the following:

These symbols represent the following characteristics:

(1) Relief (H4-1V1A-1-all)

F - flat
U - undulating
R - rolling
H - hilly
M - mountainous

(2) Depth of surface deposits to bedrock (H4-1V1A-1-all)

1 - thick (>1 m)
2 - thick and thin mixed
3 - thick with bedrock oitcrops
4 - thin and thick mixed
5 - thin (<1 m)
6 - thin with bedrock outcrops
7 - bedrock with thick deposits
8 - bedrock with thin deposits
9 - bedrock

(3) Origin and morphology of surficial materials (H4-1V1A-1-all).

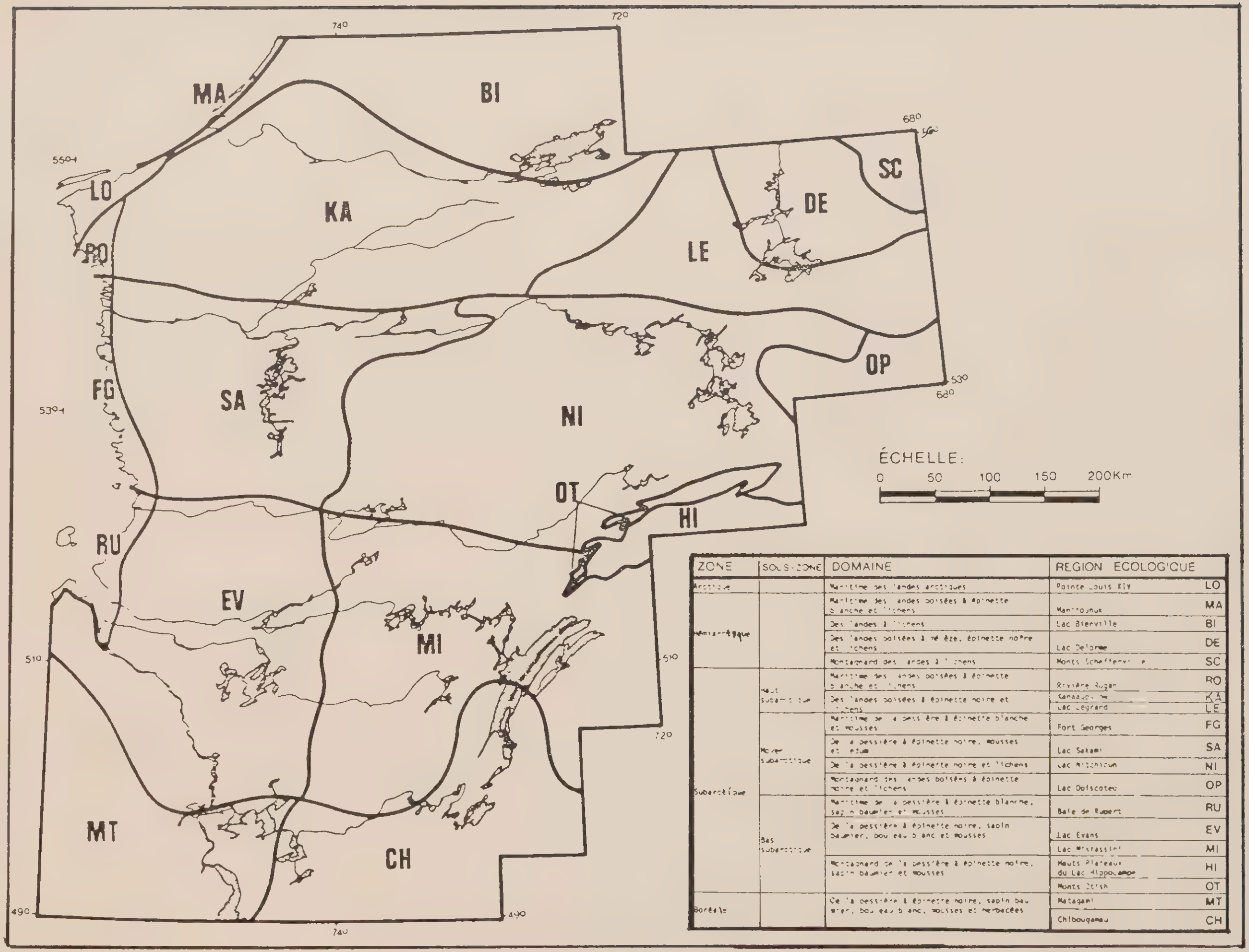
(4) Land system index card number (H4-1V1A-1-all)

(5) Aquatic parameters as listed below (H4-1V1A-1-all)

Water Bodies:
(a) less than 5% of the land system is covered by open water smaller than 250 ha.
(b) 5-15% is covered by lakes smaller than 250 ha.
(c) more than 15% of the land system is covered by lakes smaller than 250 ha.
(f) more than 15% of the land system is covered by lakes 250-500 ha in size.
(g) more than 15% of the land system is covered by lakes 500-1000 ha in size.
(h) land system through which flows a river 20-60 m in width
(i) land system through which flows a river more than 60 m wide.
(j) land system bordering the sea.
(n) land system covered over 15% by lakes 1000-2500 ha in size.
(r) land system covered over 15% by lakes more than 2500 ha in size.

Streams:
1 - none or few
2 - few
3 - average
4 - abundant

Wetland:
1 - none or few
2 - few
3 - average
4 - abundant



ZONE	SOUS-ZONE	DOMAINE	REGION ÉCOLOGIQUE	
Arctique		Maritime des landes arctiques	Pointe Louis XIV	LO
Hémiarctique		Maritime des landes boisées à épinette blanche et lichens	Manitounuk	MA
		Des landes à lichens	Lac Bienville	BI
		Des landes boisées à mélèze, épinette noire et lichens	Lac Delorme	DE
		Montagnard des landes à lichens	Monts Schefferville	SC
Subarctique	Haut subarctique	Maritime des landes boisées à épinette blanche et lichens	Rivière Rogan	RO
		Des landes boisées à épinette noire et lichens	Kanaaupscow	KA
			Lac Legrand	LE
	Moyen subarctique	Maritime de la pessière à épinette blanche et mousses	Fort Georges	FG
		De la pessière à épinette noire, mousses et lichens	Lac Sakami	SA
		De la pessière à épinette noire et lichens	Lac Nitchicun	NI
		Montagnard des landes boisées à épinette noire et lichens	Lac Opiscotéo	OP
	Bas subarctique	Maritime de la pessière à épinette blanche, sapin baumier et mousses	Baie de Rupert	RU
		De la pessière à épinette noire, sapin baumier, bouleau blanc et mousses	Lac Evans	EV
			Lac Mistassini	MI
		Montagnard de la pessière à épinette noire, sapin baumier et mousses	Hauts Plateaux du Lac Hippocampe	HI
			Monts Otish	OT
Boréale		De la pessière à épinette noire, sapin baumier, bouleau blanc, mousses et herbacées	Matagami	MT
			Chibougamau	CH

Figure 1: Ecological Regions of the James Bay Territory

lièvre - hare
épaisseur - population density
ruisseau - streams

loutre - otter
renard - fox
loup - wolf

abondant - abundant
moyen - moderate
pauvre - poor

d'échantillon - distribution

RELATION FAUNE - CARTE ÉCOLOGIQUE

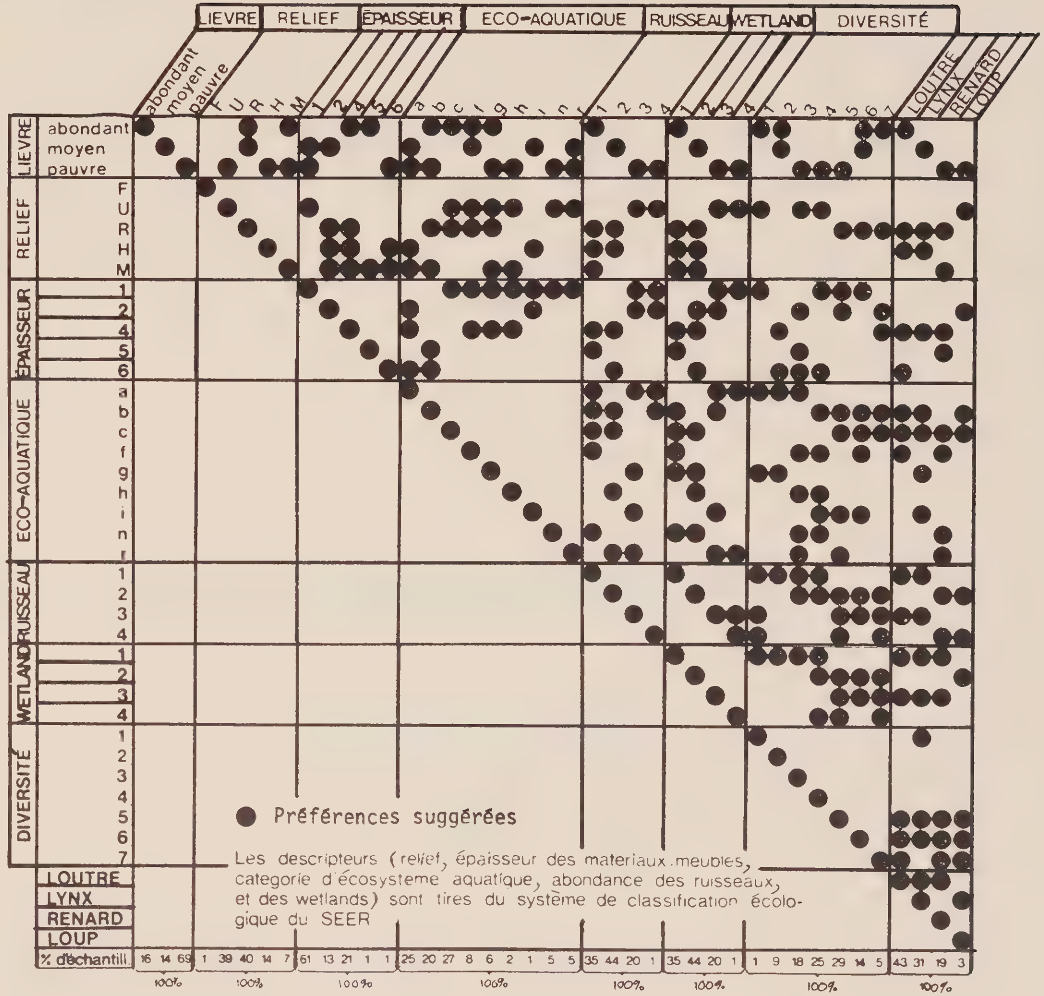


Figure 2: Ecological Interrelationships of Fauna and Ecological Parameters
(parameters are outlined in Appendix I).

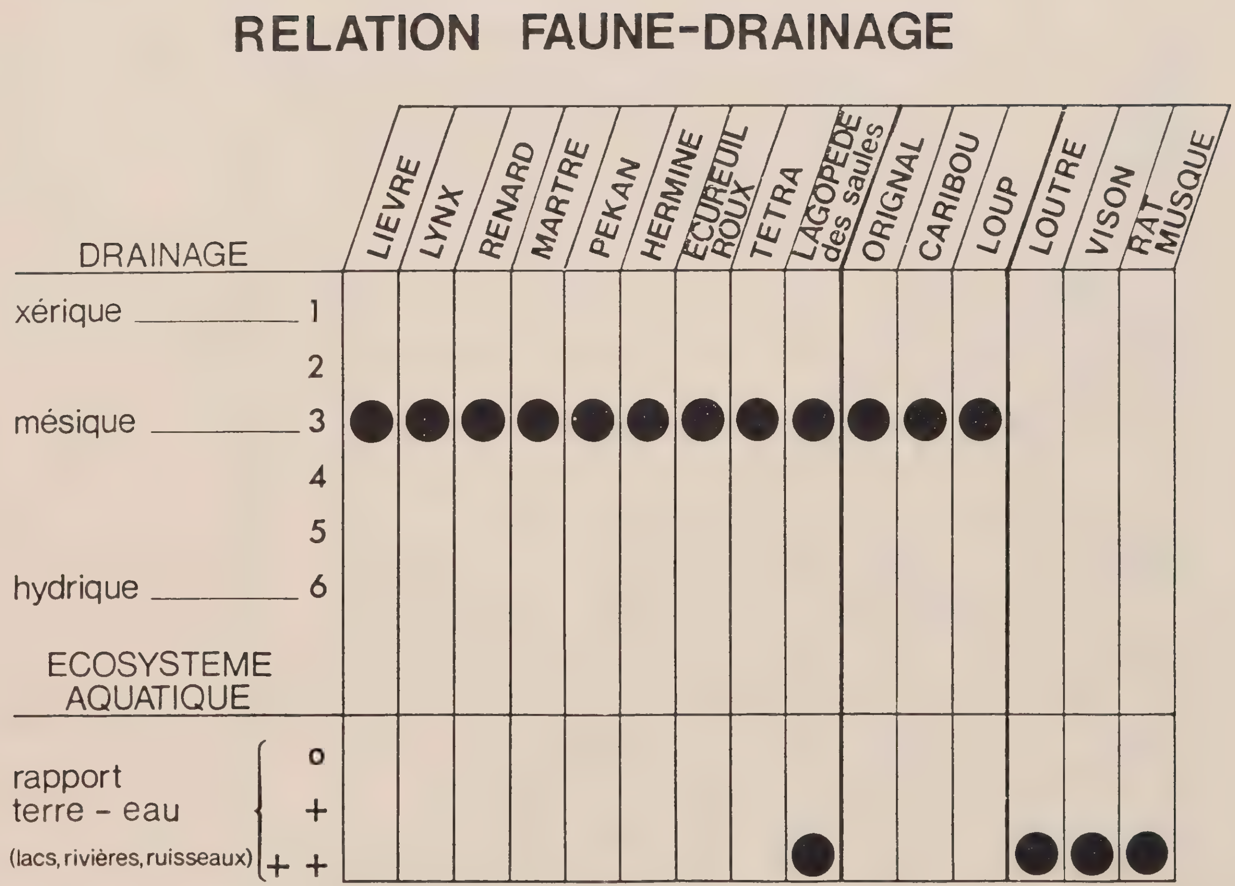


Figure 3: Ecological Relationships of Fauna to Land Drainage Conditions

Table 1: Interpretation Key for Muskrat

I	II	III	IV	V	
Catégorie d'écosystèmes aquatiques	Matériaux géologiques de surface (dominants et/ou sous-dominants)	Matériaux géologiques des rives (dominants et/ou sous-dominants)	Abondance de wetlands	Classe de potentiel	
				le scéna-rio	2e scéna-rio
b, c, f ou h		4,1*, 5 ou 7	4 ou 5	1	1
			3	1	1
			2 ou 1	3	2
		autres que 4,1*,5 ou 7	4 ou 5	2	1
			3	3	2
			2 ou 1	4	2
g, n, r, i, m ou j		4,1*, 5 ou 7	4 ou 5	3	2
			3	4	2
			2 ou 1	5	3
		autres que 4,1*,5 ou 7	4 ou 5	4	2
			3	5	3
			2 ou 1	6	3
a	4,1* ou 5		4 ou 5	3	2
			3	4	2
			2 ou 1	5	3
	autres que 4,1*,ou 5		4 ou 5	4	2
			3	5	3
			2 ou 1	6	3

Classes de potentiel

lère alternative *

1 - excellent
2 - bon
3 - bon, mais limité par l'un ou l'autre des facteurs I, II, III ou IV
4 - passable
5 - faible
6 - très faible

2e alternative **

1 - bon ou excellent
2 - moyen
3 - faible ou très faible

Table 2: Interpretation Key for Ptarmigan Potential

Catégorie d'écosystèmes aquatiques	Région Ecologique	Abondance de stations ripariennes (classe)	Classe de potentiel
J et M			1
i et h	Nord (LO,BI,DE,LE,KA,RO)	2 à 5	1
		1	2
	Centre (FG,SA,NI,OP)	3 à 5	2
		1 et 2	3
	Sud (RU,EV,MI,OT,MT,CH)	4 et 5	3
		1 à 3	4
Autres (a,b,c,f,g,n,et r)	Nord (LO,BI,DE,LE,KA,RO)	3 à 5	2
		1 et 2	3
	Centre (FG,SA,NI,OP)	3 à 5	3
		1 et 2	4
	Sud (RU,EV,MI,OT,MT,CH)	3 à 5	4
		1 et 2	5

TERRAIN CLASSIFICATION WITHIN MACMILLAN BLOEDEL

W. W. Bourgeois
Land Use Planning Advisory Team
MacMillan Bloedel Limited
Nanaimo, British Columbia

ABSTRACT

The terrain classification system currently used by MacMillan Bloedel Limited is outlined. The system proposed by the ELUC with minor modifications provides data useful in forest lands planning, engineering and management. These data improve timber development and harvesting practices. (Ed. Abstr.)

RÉSUMÉ

L'auteur présente le système de classification des terrains actuellement employé par MacMillan Bloedel Limitée. Le système proposé par la Comité environnemental de l'utilisation des terres et légèrement modifié fournit des données utiles pour la planification, l'organisation et l'aménagement des terrains forestiers. Ces données contribuent à mettre davantage le bois en valeur et à améliorer les méthodes d'exploitation forestière. (Rés. Éd.)

INTRODUCTION

In 1971 MacMillan Bloedel Limited (MB) presented a land use policy which stated that the company recognizes its obligation to preserve resource values other than timber, which are contributed by forests. To fulfil this oblication a Land Use Planning Advisory Team (LUPAT) was established, consisting of pedologists and wildlife and fisheries biologists. The responsibilities of LUPAT include resource inventories and interpretations for use by foresters and forest engineers in timber development and harvesting. Each discipline within the team has an inventory system that provides the required planning information. The individual resource data is compiled, analyzed and integrated with the data of the other resources to provide an integrated resource folio. This paper will discuss the terrain classification system used by the pedologists and the interpretations developed from the data.

WHY A TERRAIN CLASSIFICATION SYSTEM FOR MB

Land Use Policy

The desire to protect the soils, fish, recreation and aesthetic values in a watershed requires an understanding of the timber harvesting-terrain interrelationships. Stream sedimentation can be a major factor affecting fish production (Phillips, 1971) and forest roads are a major sediment contributor (Dyrness, 1967; Fredriksen, 1970). Road construction and/or clearcut harvesting have been found to increase material failures in potentially unstable areas of northwestern North America (Fredriksen, 1970; Swanson and Dyrness 1975; Swanston, 1976). These failures are potential sources of stream sedimentation and are also aesthetically displeasing to many people.

Road Construction

Road construction in coastal forests is one of the largest costs of timber harvesting and has a major bearing on logging economics. Two additional costs of road construction are road failures and poorly located or 'dead' road. Road construction costs for MB in coastal BC average approximately $43,500 per km. Therefore any inefficient or dead road construction can significantly reduce the profitability of timber harvesting. A road failure involving one half of a 30 m stretch of road would require a reconstruction cost of approximately $2,300. Road construction in the steep terrain, common to coastal BC, subjects the engineer to an increased frequency of these occurrences.

Forest Management

MB has the timber harvesting rights to 1.51 million ha of coastal BC (1.12 million ha productive). Only 20 percent (0.22 million ha) of the productive land is company owned with the remaining 0.90 million ha held under tree farm or timber licenses. In the tree farm licences (TFL) and ownership areas the company is required, by contract and policy respectively, to manage the forest on a sustained yield basis. This includes the establishing and managing of

a second growth forest. Combining soils data with that of terrain, silvics, climate and other ecological parameters is considered beneficial in prescribing forest management practices that will ensure a sustained yield forestry program.

Therefore, the company acknowledges that terrain data is a necessary input in satisfying the needs of the land use and forest management policies and also in reducing the costs of road construction on steep areas. The benefits to MB of a terrain classification system are associated with both planning and operational activities, with the emphasis placed on the former.

TERRAIN RELATED STEPS IN TIMBER HARVESTING AND REFORESTATION

The following briefly identifies the steps involved in logging and reforestation on the west coast and where terrain or soils data can be useful.

1. *Planning* - A five year plan is prepared for an area identifying the openings proposed for logging and the road network required to develop the timber. Terrain data is useful in planning.

2. *Road Layout* - The engineers layout, in the field, the road locations that are required to develop the timber and identify the logging method to be used. Terrain data is useful in both the engineering planning and operational activities.

3. *Road Construction* - After the roads are built, terrain data is useful in the operations.

4. *Logging* - Falling and yarding proceed. Terrain and soils data are useful in operational decisions, primarily where creeks or gullies are present.

5. *Site Preparation* - This usually consists of prescribed burning. Terrain and soils data are useful in the operational decisions.

6. *Reforestation* - Planting or natural regeneration occurs. Soils data is useful in the planning phase.

TYPE OF TERRAIN CLASSIFICATION SYSTEM REQUIRED

The specific factors required in a terrain classification system that will assist in decision making relative to engineering, forest management and multiple land use planning include:

1. *Engineering* - Data is needed concerning the type of material; properties of materials; topography; and wettness.

2. *Forest Management* - Data is required on soil types; and soil properties (e.g. moisture, fertility).

3. *Land Use Planning* - Requirements include engineering, forest management, fisheries (e.g. streambank material characteristics, physical soil properties), and recreation (e.g. soil properties).

TERRAIN CLASSIFICATION SYSTEM USED BY MB

The Environment Land Use Committee (ELUC) Terrain Classification System (1976) forms the basis for the system used by MB. The ELUC system allows for a general description of the land base through the identification of the terrain unit and also provides the required engineering information regarding the types, general texture and relative depths of material. The system also identifies the geological processes that may have a bearing on the engineering and logging prescriptions assigned to each land unit. The types and properties of materials along streams are also provided by the ELUC system and are necessary for interpretations regarding logging adjacent to streams.

There are some limitations within the ELUC system relative to the company requirements. As indicated by the previous list of required parameters, the system does not provide some of the necessary data. This data can be grouped into soils and topography, although general slope indications are present in some surface expression notations. Another factor that results in limitations in some instances is the scale for which the system is designed (i.e. 1:50,000 or smaller).

MB conducts inventories at two levels - (a) reconnaissance (1:63,360) and (b) detail (1:15,840). Terrain information is most useful if collected and presented at a scale of at least 1:15,840. However, there are limitations to the operational benefits of data at this scale. A smaller scale data base (e.g. 1:63,360) does not provide the necessary detail for planning or operational decisions. The reconnaissance data is used only as an indicator of the general problems in the area and for identification of areas where more detailed information is necessary.

MB has modified, the ELUC system primarily in the form of additions, to remove some of the limitations from the company standpoint. These modifications are assigned to the detailed

inventory only and the ELUC system is used in its entirety for reconnaissance inventories.

Modifications

Slopes - Each mapping unit is identified according to one of five slope classes indicating the general slope of the unit. An engineering bias is incorporated into the slope classification with the primary emphasis on terrain stability and yarding method limitations. Topographic categories include:

Gently sloping	(A)	$0-10^{o}$
Moderately gently sloping	(B)	$10-20^{o}$
Moderately sloping	(C)	$20-30^{o}$
Steeply sloping	(D)	$30-35^{o}$
Very steeply sloping	(E)	$> 35^{o}$

Where required, complexing of slope classes is identified with the same notation as the unconsolidated materials composite units (ELUC, 1976).

Modifying Processes - The term 'failing' (F) refers to recent slides or units containing many failures. The modifier is applied to both consolidated and unconsolidated materials. Process status is active.

Example: (Cv-F) Debris slides(s) on shallow colluvial material.

'Soil creep' (*) is an additional process described as the slow downslope movement of unconsolidated materials resulting in significant tree sweep in mature timber.

Example: (Mb-*) Deep morainal material exhibiting significant soil creep.

Soil Moisture Regimes (SMR) - The SMR classification is a combination of soil drainage characteristics, relative wettness characteristics inferred from the biogeoclimatic subzones (Packee, 1974) and the wettness descriptions proposed by Leskieu (1973). On Vancouver Island (VI) and the coastal mainland six classes are inventoried but only five classes are used in the Queen Charlotte Islands (QCI). The reason for the QCI deviation is due to the problems associated with mapping the sixth class. During field checking, six classes can be identified in the QCI but a continuous complexing of classes would appear on the map. Consequently the adopted approach has been that these differences be identified site specifically in the field by the operational personnel and the appropriate interpretations applied. Table 1 compares the VI and QCI soil moisture regimes classes.

Onsite Symbols - not used.

Terrain unit - consists of landform, slope class and soil moisture regime.

In summary, the MB system used in reconnaissance inventories involved identification of terrain units as defined by the ELUC but in detail inventories the units also contain slope and slil moisture regime classes.

PRESENT EXTENT OF MB TERRAIN INVENTORIES

An area of 108,000 ha has been inventoried at a scale of 1:15,840 primarily on the west coast and northeast coast of VI and in the QCI.

An area of 63,200 ha has also been inventoried at a scale of 1:63,360. These are areas where the Resource Analysis Branch (RAB) of the Provincial Ministry of the Environment has not conducted an inventory (i.e. QCI and coastal mainland). In areas where the RAB data is available, it is used as reconnaissance data for the appropriate MB decisions.

The detail inventories have been conducted for either multiple land use (68,000 ha) or engineering planning only (40,000 ha).

TERRAIN DATA INTERPRETATIONS

The following are the major types of interpretations made from the detailed terrain data with the emphasis on the engineering aspects.

Terrain Stability

Each terrain unit is assigned one of five terrain stability ratings, based on the landform type, material texture, steepness of slope, length of slope, soil type, soil moisture regime, landscape position, and underlying bedrock type. The ratings are determined by weighing the relative importance and extent of each of the physical factors based on information in the literature and observations of failures. It should be noted that these ratings are indicative of the natural stability which could be reduced in certain instances through disturbance. A brief description of the potential damage that can be expected through different types of disturbance associated with each of the five stability classes is presented in Table 2.

Logging

(i) Logging around gullies may or may not induce failures depending on the type of gully and the yarding system used. Gully morainal blanket (Mb-V) terrain generally has relatively shallow gullies. Only a small amount of significant

Table 1: Comparison of Vancouver Island (VI) and Queen Charlotte Islands (QVI) Soil Moisture Regime Classes

Soil Moisture Regime	VI	Soil Drainage	QCI	Soil Drainage
Very low	1	rapidly drained, soil, shedding rock outcrop	1	rapidly drained, soil, shedding rock outcrop
Low	2	well drained soil	2	moderately well drained soil
Medium	3	moderately well drained soil		
Moderate	4	imperfectly drained soil	3	imperfectly drained soil
High	5	poorly drained soil	4	imperfectly poorly drained soil
Very High	6	very poorly drained soil	5	very poorly drained soil

Differences in soil drainage may occur between general areas depending on the biogeoclimatic subzone involved.

General Interpretations of Stability Classes

Class	Description
I	No significant stability problems exist.
II	No significant stability problems exist, however, an awareness of a potential for induced instability is required.
III	Some minor instability problems could develop relative to road construction.
IV	Disturbance during and following road construction can readily produce stability problems. Some minor failures can be expected after clearcutting.
V	Significant stability problems could develop through road construction or clearcutting disturbance.

Table 2: Interpretations of terrain stability classes used by MacMillan Bloedel

disturbance occurs if yarding proceeds across these gullies. However, deep gullies (e.g. rock or fluvial gullies) will have any unconsolidated material present severely disturbed if the yarding direction is across.

(ii) Ground skidding machines can be used to advantage if the soil moisture conditions and material types are favourable. Rubber tired skidders are suitable for dry, gravelly fluvial deposits but have limitations on wetter sites. Low ground pressure track machines are suitable for many of these wetter sites and also for steeper terrain (e.g. $< 25^{o}$).

Road Construction

(i) Slides induced through poor road construction or drainage practices are a major environmental problem considered in the interpretations of the terrain data. Road construction through steeply sloping areas can cause road failures if the road is not fully benched. The major factors used in this interpretation are type and texture of material, steepness of slope, and climatic conditions. Poorly located culverts or inadequate ditches can induce road instability problems in certain types of terrain (e.g. shallow deposits on very steep slopes).

(ii) Slumping or sloughing of material along road cuts is a common problem when roads transect deep materials associated with slopes in excess of 30^{o}. The type of failure will depend on the nature of material (e.g. slumping associated with deep morainal deposits or continuous receding upslope of a road cut through rubbly colluvium).

(iii) Timing of road construction in dry periods is necessary in some areas if sediment production is to be minimized. One example is road construction through a high soil moisture regime area of deep morainal deposits in the QCI. Sidecasting of this material during wet periods commonly results in material failure. However, if the construction proceeds during a drier soil moisture condition, the material appears to 'set-up' and failures are infrequent.

(iv) The construction method (e.g. shovel versus tractor) can have a significant impact on sediment production and the economics of road construction. Certain terrain units are more suitable to shovel construction (e.g. deep morainal deposits associated with moderate to very high soil moisture regimes on the west coast of VI or on the QCI), while tractors are desirable on rubbly colluvial materials unless a very high soil moisture regime is present.

(v) The relative amount of drainage water expected to be collected by a road will be dependent upon the soil moisture regime (e.g. high soil moisture regime areas will produce more drainage water than areas of medium soil moisture regime).

(vi) Potential gravel sources are identified through landform type (e.g. fluvioglacial landforms).

Potential Windthrow Areas

The present patch system of timber harvesting has resulted in a very significant windthrow problem. The strong, winter winds that are common on the west and northeast coast of VI and throughout the QCI have produced a great deal of blowdown along edges of leave blocks and leave strips. Blown down trees are of less value than standing trees due to both the reduction in wood quality, either through breakage or rot, and the increased costs of harvesting. Where trees are blown down on very steep slopes they commonly induce debris slides. A major factor associated with harvesting blowdown is the greatly increased safety hazard of harvesting the trees. The identification of potential windthrow sites can be done using the soil moisture regime, landform, bedrock, aspect and geographic factors. Moderate to very high soil moisture regimes, shallow deposits, unfractured bedrock, aspect and geographic factors. Moderate to very high soil moisture regimes, shallow deposits, unfractured bedrock, southern aspects, valley constructions and ridgetops are factors that increase the potential for windthrow. The terrain classification system provides data on many of these factors.

Forest Management

The forest management practices where terrain and/or soils data can be useful include site preparation, reforestation, thinning and fertilization. In the past there has not been an extensive and detailed use of soils or terrain information in decision making relative to these practices. However, this is rapidly changing as indicated by the activities of MB and British Columbia Forest Products (BCFP) in using ecosystem approaches to forest management.

the systems used by the two companies are slightly different but both contain a soils or terrain component in the site evaluation. At the present time it is not clear to what extent terrain data provides the necessary answers and where more detailed soils data is required. This decision will depend on the management practices of concern. For example, slashburning decisions may require only terrain data relative to erosion potential while only soil information will provide the answer to fertilization evaluations.

Streamside Management

Fisheries biologists are concerned about stream sedimentation and although the greatest amount of sediment production is usually associated with roads and debris slides, the characteristics of the streambanks and activities around streams can have a significant influence on stream sedimentation. The terrain inventory provides data on the expected characteristics of the streambanks, the potential for windthrow of any leave strips and the potential damage of yarding across the streambanks. The very frequent change in streambank and streamside characteristics requires site specific evaluations in each setting. The use of the terrain classification system during the site specific investigations adequately characterizes the physical features of the streambanks and streamsides.

IMPROVEMENTS TO THE TERRAIN CLASSIFICATION SYSTEM AND INTERPRETATION

Other than the general improvement through increased knowledge be it research or experience, of terrain data interpretations, there are a few areas where a concentrated effort is required. From the company standpoint these areas are:

1. A quantification of moisture content of various soil moisture regime types throughout the year. This data is necessary for interpretations relative to seedling planting and design of culverts and ditches.

2. An expansion of forestry interpretations, especially relative to soils data with emphasis on species preference for regeneration and soil productivity.

3. A better understanding of the interrelationships between terrain units and the vegetation communities which they support. This will improve the use of the ecosystem approach for assigning forest management prescriptions to the site.

SUMMARY

A terrain classification system is of value to MB through its provision of data useful in the planning and operational phases of land use planning, engineering and forest management activities. The system proposed by ELUC provides the major requirements for the company, however, some minor modifications, primarily in the areas of soil moisture regime and slope classes, are necessary. Interpretations of the terrain data have been shown to improve timber development and harvesting practices from both environmental and economic perspectives.

REFERENCES

Dyrness, C.T. 1967. Mass soil movements on the H.J. Andrews Experimental Forest. U.S.D.A. For. Serv. Res. Pap. PNW-42.

ELUC Secretariat. 1976. Terrain Classification System. Ministry of Environment, Victoria, B.C.

Frederiksen, R.L. 1970. Erosion and sedimentation following road construction and timber harvest on unstable soils in three small western Oregon watersheds. U.S.D.A. For. Ser. Res. Pap. PNW-104.

Leskieu, L. 1973. Soil drainage proposal presented to 9th Canada Soil Survey Committee Meeting, Saskatoon, Sask.

Packee, E.C. 1974. The biogeoclimatic subzones of Vancouver Island and the adjacent mainland based on climax vegetation. MacMillan Bloedel Limited. Map and Report.

Phillips, R.W. 1970. Effects of sediment on the gravel environment and fish production. *in* Proc. Symposium or Forest Land Uses and Stream Environment. Oregon State University.

Swanson, F.J. and Dyrness, C.T. 1975. Impact of clearcutting and road construction on soil erosion by landslides in the western Cascade Range, Oregon. Geology 3 (7): 393-396.

Swanston, D.N. 1976. Erosion processes and control methods in North America. *in* Proc. VI IUFRO World Congress, Div. I.

LAND CLASSIFICATION FIELD TRIP
EXCURSION SUR LA CLASSIFICATION DU TERRITOIRE

BCFP 1-2

BCFP 2

BCFP 1-2

FIELD TRIP

On April 7, 1978 a field trip was arranged by British Columbia Forest Products Ltd. and MacMillan Bloedel Ltd. to allow CCELC members to view the applications of ecological land classification to forest management by these companies on Vancouver Island. The trip ran from 7 AM to 8 PM, a long but most interesting day. Features of the sites visited on this trip are outlined below and the stops are located on Figure 1 for each of the companies' sectors.

B.C. Forest Products Sector

BCFP 1-1: Skutz Falls Cutoff, Cowichan Valley Demonstration Forest; a mature red alder forest in the coastal Douglas fir wetter subzone; lower slope with poor drainage.
BCFP 1-2: Upslope site with mature red alder on drier soils on alluvial fan deposit.
BCFP 1-3: Further upslope with red alder on medium textured morainal blanket, relatively dry site.
BCFP 2: Cottonwood Creek at Maple Grove Park; a coastal western hemlock forest in the dry subzone; gravelly alluvial fan.

MacMillan Bloedel Sector
(Franklin and Sarita Forest Divisions)

MB 1: Cowichan Lake - forest ecosystem classification and applications to forest management; high site quality.
MB 2: Youbou - active logging and hauling from highly productive sites.
MB 3: Flora Lake - coastal forest management practices.
MB 4: Branch Road 209D - road construction problems on steep terrain; tree species selection.
MB 5: Klanawa West Fork - clearcutting on steep terrain, cross stream yarding and natural debris failures.
MB 6: Darling Main 1 - road construction practices, soil variability and morphology, forest management.
MB 7: Darling Main 2 - road induced slope failure; coastal geomorphology.

The photographs included in this section are annotated with the number of the stop where each was taken.

EXCURSION

Le 7 avril 1978, une excursion sur le terrain a eu lieu sous, les auspices des sociétés British Columbia Forest Products Ltd. et MacMillan Bloedel Ltd., afin de permettre aux membres du CCCET d'observer les applications de la classification écologique des terres à l'aménagement forestier et les applications réalisées par ces sociétés dans l'île Vancouver. L'excursion a duré de 7 h à 20 h, et le long itinéraire a été fort intéressant. Les points saillants de la visite sont énumérés ci-dessous, et les haltes relatives à chaque secteur des sociétés en question sont indiquées à la Figure 1.

Secteur de la B.C. Forest Products

BCFP 1-1: Forêt de démonstration située près du repli de la Cowichan à Skutz Falls; peuplement mûr d'aulne rouge dans une sous-zone humide de couvert côtier de sapin de Douglas; bas de talus mal drainé.
BCFP 1-2: Un site, en amont du précédent, portant un peuplement mûr d'aulne rouge sur les sols plus secs d'une plaine alluviale en éventail.
BCFP 1-3: Encore plus en amont; aulnes rouges sur moraine à consistance moyenne et sols assez secs.
BCFP 2: Ruisseau Cottonwood, dans le parc Maple Grove; peuplement côtier de pruche de l'ouest dnas une sous-zone sèche; éventail alluvial de gravier.

Secteur de la MacMillan Bloedel
(Divisions forestières de Franklin et de Sarita)

MB 1: Lac Cowichan - la classification des écosystèmes forestiers et ses applications à l'aménagement forestier; site de qualité.
MB 2: Youbou - abattage et débardage dans des sites très productifs.
MB 3: Lac Flora - pratiques d'aménagement des forêts côtières.
MB 4: route d'accès 209D - problèmes de construction routière en terrain incliné; sélection d'essences forestières.
MB 5: Bras ouest de la Klanawa - coupe rase en terrain incliné, débusquage avec traversée de cours d'eau, et fuites du bassin de sédimentation.
MB 6: Chemin principal Darling 1 - pratiques de construction routière, variabilité des sols et géomorphologie, aménagement forestier.
MB 7: Chemin principal Darling 2 - affaissement de pente attribuable à la construction routière; géomorphologie côtière.

Chaque photographie que comprend la présente section du rapport porte le numéro de la halte où elle a été prise.

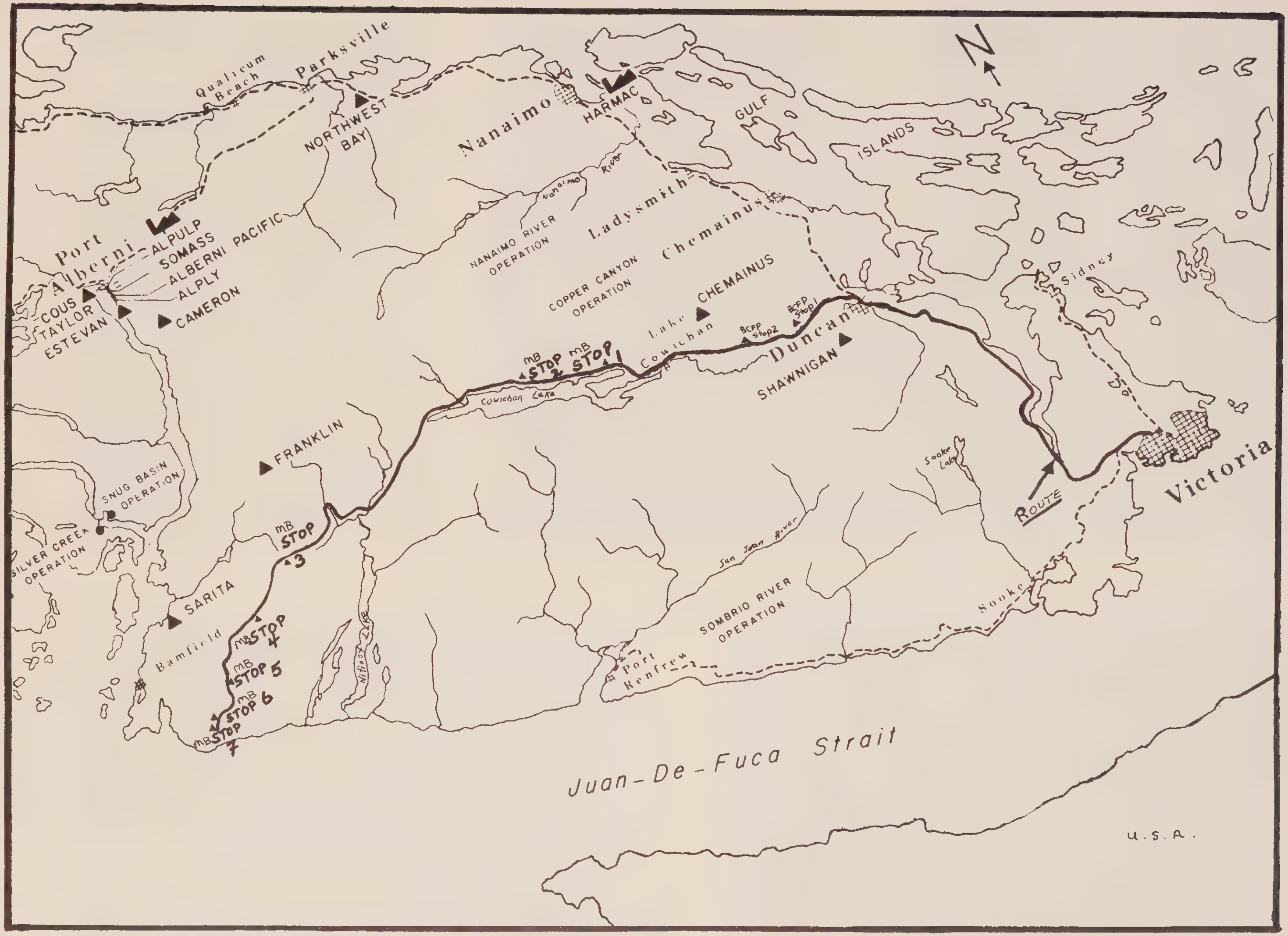


Figure 1: Route of CCELC Field Trip, April 7, 1978
La Route d'Excursion CCCET, le 7 avril, 1978

BCFP 2

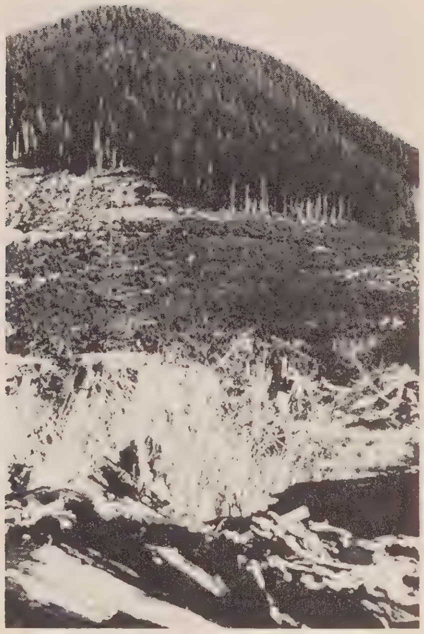
MB 4

BCFP 1

MB 6

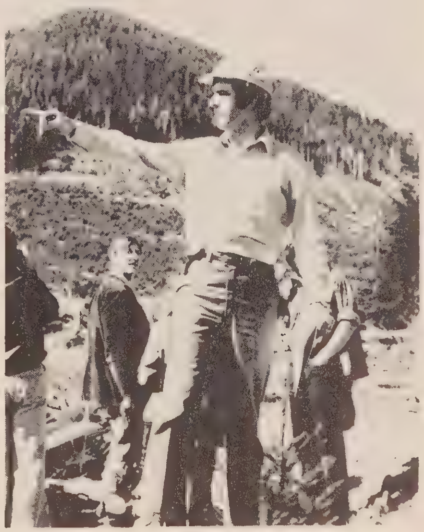
MB 5

MB 4



MB 4

MB 4



MB 4

MB2

MB7

MB5

MB6

ECOLOGICAL LAND CLASSIFICATION OF THE HUDSON BAY LOWLAND COASTAL ZONE, ONTARIO

D. W. Cowell and G. M. Wickware
Lands Directorate
Environment Canada
Burlington, Ontario

R. A. Sims
Canadian Forestry Service
Environment Canada
Sault Ste. Marie, Ontario

ABSTRACT

An ecological land classification project for the coastal zone of the Hudson Bay Lowland in Ontario has been undertaken. The coastal zone is defined on the basis of hydrologic, vegetative and physiographic characteristics. Ecologically, it represents a distinct zone between Hudson and James Bays and the mature peat complexes of the interior. The coastal zone is, in fact, two Land Regions separated on the basis of climate. It is an internationally important area for migrating, breeding and nesting waterfowl and other shorebirds. The project is designed to provide habitat information relating to these concerns as well as establishing a framework for environmental impact assessment and further scientific research.

Classification is being carried out at four levels: Land Region, Land District, Land System and Land Type. These are defined and examples from the 1977 study area are given. The Land System is the basic mapping level and to date 4000 km^2 of the coastal zone between the Albany River and the Ontario-Quebec border has been classified and mapped at a scale of 1:100,000. During the 1977 field program data on soils, vegetation, hydrology and physiography were collected at 154 sites within this area. This information has been used to formulate the Land System mapping legend and will be analyzed in more detail to form the basis of an ecological report. An example of the legend and its application is provided for an area taken from the Albany map sheet. A brief discussion of the composition and distribution of Land Systems is also presented.

RÉSUMÉ

On a entrepris un projet de classification écologique dans la zone côtière des basses terres de la baie d'Hudson en Ontario. La zone côtière se definit comme telle selon des caracteristiques hydrologiques, physiographiques et végétales. Du point de vue écologique, elle représente une zone distincte entre les baies d'Hudson et James et les vastes champs de tourbe mature de l'intérieur. Elle se compose en fait de deux régions écologiques qui se distinguent par leur climat. Sur le plan international, elle représente un important bassin de migration, de gestation et de nidification pour les oiseaux de rivage. Le projet vise à recueillir des données sur l'habitat, et à établir une structure pour l'évaluation des incidences environnementales et d'autres projets de recherche scientifique.

La classification est entreprise selon quatre échelles: la région, le district, le système et le type écologiques. On donne les définitions de ces échelles, ainsi que des exemples de l'étude entreprise en 1977. Le système constitue l'échelle topographique de base et, jusqu'à maintenant, 4 000 km^2 de la zone côtière entre la rivière Albany et la frontière québécoise ont été classifiés et établis sur cartes à l'échelle de 1:100 000. Au cours du programme sur le terrain en 1977, on a recueilli dans cette région des données sur les sols, la végétation, l'hydrologie et la physiographie dans 154 emplacements. Ces données ont servi à établir la légende des cartes des systèmes et elles serviront de fondement pour un rapport écologique détaillé. Un exemple de légende et de ses applications est fourni pour une région figurant sur la feuille topographique de la région de la rivière Albany. Le rapport présente également une discussion sur la composition et la répartition des systèmes écologiques.
(Trad. Éd.)

INTRODUCTION

The Hudson Bay Lowland is an expansive coastal plain located between the Canadian Shield and the south and west shores of Hudson Bay. Ecologically it is one of the most distinct regions in Canada but is also one of the least known or studied. Research by the Canadian Wildlife Service and the Ontario Ministry of Natural Resources has shown that the coastal zone of the Hudson Bay Lowland is of major international importance for many species of geese, ducks and shorebirds, including species whose existence is threatened or endangered. The coastal zone forms a major migration route to and from Arctic breeding areas, and also provides habitat for substantial breeding populations and shorebirds. Inland, the vast expanse of bog and fen, in combination with a myriad of pools, ponds and lakes provide important nexting habitat for the Canada Goose and several species of duck.

Because of this national and international significance, the Environmental Management Service of Environment Canada has undertaken an integrated research and ecological classification program for the coastal zone of the Hudson Bay Lowland. The coastal zone has been selected because of its significant concentrations of migratory birds and because considerable data on population dynamics of some of these species has now been collected.

The classification will provide habitat information important for further migratory bird population research as well as providing baseline information and a framework for further environmental impact assessment studies. A program of this nature is especially critical in view of potential developments within the Lowland such as pipeline construction, oil and gas exploration, hydro-electric development and lignite extraction.

STUDY AREA

The Hudson Bay Lowland stretches approximately 1400 km from Churchill Manitoba to the Rupert River in Quebec and has a maximum width of 520 km (Figure 1). The Lowland has an area of 325,000 km^2 of which 260,000 km^2 lie within the province of Ontario. The Sutton Ridges located southwest of Cape Henrietta Maria are the only significant topographic features which break the monotony of the coastal plain. It otherwise has a gradient of only 0.5 to 1.0 m/km from the shield (at 160 to 200 m A.S.L.) to the sea.

The Lowland is underlain by Paleozoic strata of the Hudson Basin. These are predominately limestones, dolomites and sandstones of Ordovician, Silurian and Devonian ages (Sanford, Norris and Bostock, 1968). Deglaciation occurred 7,000 to 8,000 years B.P. and since that time up to 150 m of uplift has taken place in the region (Andrews 1969). The level of maximum marine inundation by the Tyrrell Sea corresponds approximately with the southern and western boundaries of the Hudson Bay Lowland.

The gentle gradient in combination with a cool humid climate (subarctic to arctic) has resulted in an extensive and largely unconfined peatland complex. The organic deposits overlay substrates of marine clay, coarse beach materials or glacial debris and vary in depth from 1 to 4 meters. The entire region is waterlogged except for the limited physiographic expression provided by raised beach ridges and river levées. These occupy approximately 10 to 15% of the area. Seven major rivers representing most of the drainage area of central and western Canada flow through the Lowland. These are the Churchill, Nelson, Severn, Winisk, Attawapiskat, Albany and Moose Rivers. They form the only real barriers to the unconfined peat complex.

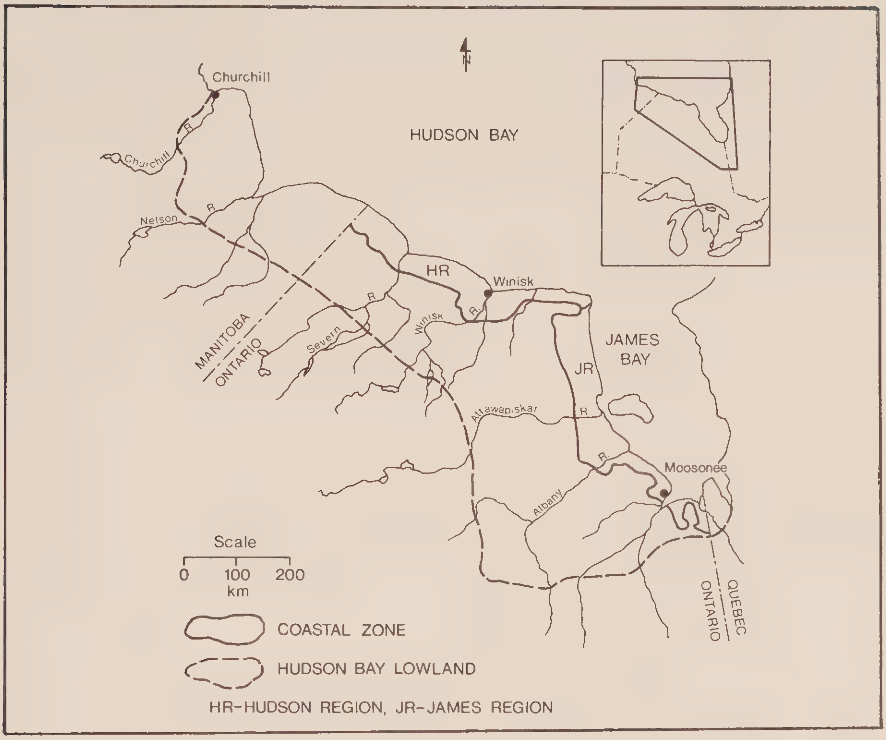
For practical scientific and management purposes the coastal zone (Figure 1) has been defined as follows:

> The Coastal Zone is that part of the Lowland which is characterized by a distinctive hydrologic, vegetative and physiographic regime bordered on the one side by the waters of Hudson and James Bays, and on the other by the mature peatland complex of the Hudson Bay Lowland.

Essentially, the zone forms that portion of the Lowland most recently emerged from the sea and is dominated by a mineral substrate which in turn influences the composition of the vegetation, the nature of the hydrologic patterns and the physiography, as revealed by an abundance of former beach ridges. The length of the coastal zone in Ontario is approximately 1,150 km.

The coastal zone can be subdivided into two major physiographic zones: 1) the shore zone (active marine complex), and 2) the emergent zone (freshwater marsh-fen-raised shoreline complexes).

Figure 1: The Hudson Bay Lowland showing the coastal zone boundary



OBJECTIVES

i) To establish a classification for the coastal zone of the Hudson Bay Lowland which is ecological, integrated and hierarchical in approach; which provides a baseline description of the biological and physical characteristics of the area; and which will provide a framework for further habitat assessment, environmental impact and other research programs.

ii) To prepare ecological maps of the coastal zone at various scales (1:100,000 to 1:1,000,000) demonstrating the inter-relationships of the various resource components, and prepare a detailed report including analyses and descriptions of ecological units.

METHODOLOGY

Although a number of different approaches to land classification have been developed, the approach adopted for this study is similar in concept to that proposed by the Subcommittee on Biophysical Land Classification (1969) and more recently by the Canada Committee on Ecological Land Classification (1977).

The classification as developed to date, is both integrative and hierarchic in concept and has five levels of classification (Figure 2). It is designed to accommodate a classification of both the coastal zone and the interior regions of the Lowland. Although mapping is carried out at the first three levels, field investigations are at the Land Type and Land Phase levels. Information collected during field studies is used not only for classification and mapping purposes, but also for more detailed ecological analyses.

It is expected that the classification system will provide a broad range of resource information to a wide variety of individuals concerned with the planning, management and scientific study of the area's resources.

Figure 2: The five levels of ecological land classification and corresponding mapping scales for the Hudson Bay Lowland coastal zone.

CLASSIFICATION LEVEL	CHARACTERISTICS	MAPPING SCALE
Land Region	An area of land characterized by a distinctive regional climate and gross hydrologic, vegetative and physiographic regimes.	1;1,000,000
Land District	An area of land characterized by distinctive patterns of physiography and vegetation.	1:250,000 to 1:500,000
Land System	An area of land characterized by recurring patterns of landform, hydrology and vegetation.	1:100,000
Land Type	An area of land characterized by a common landform or landform segment and associated vegetation, hydrologic regime and fairly homogenous combination of soils.	1:10,000 to 1:20,000
Land Phase	A landform segment with a common vegetation community and water table regime.	1:2,000

STUDY PROGRAM

Team Approach

Planning for the project began during the fall of 1975. Although a limited field program was undertaken in the summer of 1976, the primary emphasis during the first year was on reviewing the literature, preparing a comprehensive bibliography, (Howarth, Cowell and Sims, 1978) and refining the principal objectives of the program. The classification project was begun during the winter of 1976 when a three man team with expertise in geomorphology, pedology, vegetation ecology and remote sensing was established.

In addition to the classification team, other scientists are conducting detailed studies in the shore zone of the Hudson Bay Lowland. This latter group is collecting detailed information on salt marsh ecology including vegetation, soil geochemistry and sedimentological processes. Scientists from the Canadian Wildlife Service are continuing their studies of migratory birds. Information from these programs is available to the members of the classification team.

Data Collection, Compilation and Presentation

Field studies were carried out during the period

26 July to 31 August, 1977. Field transportation was a Bell 206A helicopter equipped with pontoons. Flights were made daily from a base camp in Moosonee. A total of 154 sites were sampled during the field season for site specific information on soils, vegetation, landforms and hydrology. Approximately 45-60 minutes were required to complete the necessary data collection at each site.

Field data were recorded on specially prepared cards similar to those used by Jurdant (1977). Based on our 1977 experience further modifications to these cards will be made prior to the 1978 field season. All data recorded during the field program have been transferred into computer format to facilitate statistical analyses.

Data presentation will take two forms; a map of the ecological units at three levels (Region, District and System), and a written report which provides more detailed description of the various classification units and results of the analyses of site data. These analyses will provide more specific understanding of within and between site habitat relationships, as well as macro-scale processes operating in the coastal zone.

In addition to the ecological classification maps, several resource and suitability type maps have been prepared of vegetation types, depth of peat, hydrology, degree of paludification, and habitat suitability for nesting geese. Other maps can be prepared, depending on the particular requirements of the user. To date, 4000 km^2 of the coastal zone between the Albany River and the Quebec border has been classified and mapped.

Remote Sensing

Ecological Land Classification by its nature, makes extensive use of aerial photography as well as other remote sensing techniques. For the most part, the Hudson Bay Lowland is covered by recently acquired 1:60,000 scale, panchromatic black and white aerial photography. Only in the southern most part of James Bay was it necessary to use older (1954) photography. The photography was considered adequate for the mapping and classification of the 'emergent zone'. In the 'shore zone' however, the photography is inadequate and acquisition of additional photography is essential before complete mapping in this zone can be considered satisfactory.

Large scale (1:3,840; 1:7,680 and 1:11,520) 70 mm colour infrared photography was acquired for selected transects in the study area. Additional smaller scale photography (1:60,000, 1:30,000) planned for the 'shore zone' was not obtained because of poor weather conditions.

Preliminary investigations using digital LANDSAT data and automatic classification techniques were carried out prior to the 1977 field season. Initial results (Figure 3) have been used to demonstrate ecological emergence relationships on an area of the James Bay coast near the Kinoje River. Further investigation suggests that small scale (1:250,000) wetland classification in this environment can be successful and further research in this area is planned for 1978.

DESCRIPTION OF ECOLOGICAL UNITS

Land Regions

The Hudson Bay Lowland coastal zone has been divided into two Land Regions: the Hudson Region and the James Region (Figure 1).

The Hudson Region, located in the zone of continuous permafrost, is dominated by abundant parallel beach ridges which extend inland from the coast up to 60 km and has extensive tidal flats and salt marsh areas. Tundra vegetation and landform features associated with permafrost conditions (thaw lakes, patterned ground) occur throughout this region. Drainage is very poorly developed because of the many raised beach ridges.

The James Region is characterized by expansive salt marshes and tidal flats which, in the southern half of the region, are dominated by estuarine influences of four major rivers (Attawapiskat, Albany, Moose and Harricanaw). A section of the coast between the Albany and Moose rivers is characterized by numerous, long promontories which probably represent former locally deposited glacial material. Raised beach ridges are less common than in the Hudson Region. Instead, the emergent zone is dominated by dendritic and parallel drainage systems with extensive freshwater marshes and fens.

Land Districts

Land Districts are delineated on the basis of dominant vegetation, hydrology, and geomorphic characteristics. Fifteen Land Districts have been delineated to date in the area between the Quebec border and the Albany River (Figure 4). Table 1 provides a brief description for three of the major Land Districts in the 1977 study area.

Land Systems

The basic mapping and classification level of

Table 1: Land Districts of the Southern James Bay Coastal Zone

REGION	DISTRICT	AREA (sq. km)	CLASSIFICATION CHARACTERISTICS PHYSIOGRAPHY	HYDROLOGY	PHYSIOGNOMY
James	Hb Hannah Bay	215	Extensive tidal zone resulting from the deposition of alluviam from the Harricanaw and Missisicabi Rivers. -The alluvium has been reworked into minor beach ridges and other tidal zone features (eg. sand waves). -Following uplift a curvilinear ridge pattern has been created on an otherwise featureless plain.	-Narrow tidal creeks emerging from the freshwater marshes cut across the tidal flats. -small pools (<.5 ha.) and ponds (.5-1.0 ha) scattered throughout the marsh/fen zone occupy approximately 5-10% of the area. -Two major fluvial systems, the Harricanaw and Missisicabi Rivers contribute significantly to the estuarine conditions dominant throughout the Hannah Bay area of South James Bay.	-In the lower Tidal areas, vegetation and salinity are more characteristic of the freshwater/brackish marsh types than of true saltmarsh. In the higher tidal reaches more characteristic saltmarsh is developed as evaporation effects become more important/ -On the minor ridges and river levees Thicket Swamp/Conifer Swamp are the most dominant wetland types. -Freshwater Marsh nearest the coast and Graminoid Fen further inland dominate the inter-ridge area.
James	Kr Kesagami	560	-Expansive wetland complex broken by two rivers and several smaller creeks and streams. -Deep peats (1.6-3.0 m) are characteristic of this District. -Bedrock exposed along river beds of Atik and Kesagami Rivers. -Slumping occurs along the banks of the two rivers.	Several rivers and a number of minor creeks and streams drain this peatland complex. -Small pools are found scattered throughout the Graminoid Fen areas. Open water occupies less than 5% of the total area.	-Conifer Swamp/Upland Forest occur along major river levees. Along the edges of creeks and riparian banks Thicket Swamp prdominates. -Treed Fen/Graminoid Fen occupy the inter-fluvial areas. Small Treed Bog/Shrub Bog Islands (ie. Black Spruce Island) (≤ 1 ha.) are found scattered throughout the Fen areas.
James	Lr Longridge	175	-Coastline dominated by low promontories and well developed longitudinal beach ridges. -Organic deposits (80-160 cm.) are underlain by glacial till modified by marine activity.	-Between the ridges, larger lakes (> 1 ha.) and ponds (.5-1 ha.) occur. Water bodies are generally shallow (< 1 m.) and may have some accumulation of calcium carbonate (Marl Lakes). -Free standing water occupies 5-10% of the District.	-Upland Conifer forests with lichen/feathermoss/sphagnum spp ground flora are found on the major ridges. -Saltmarsh development very limited. -Occurs most extensively on the up-current side of promontories (northwest side). -Freshwater marsh restricted to lake edges (nearest the coast) and grades to Graminoid Fen/ Treed Fen as peat accumulates.

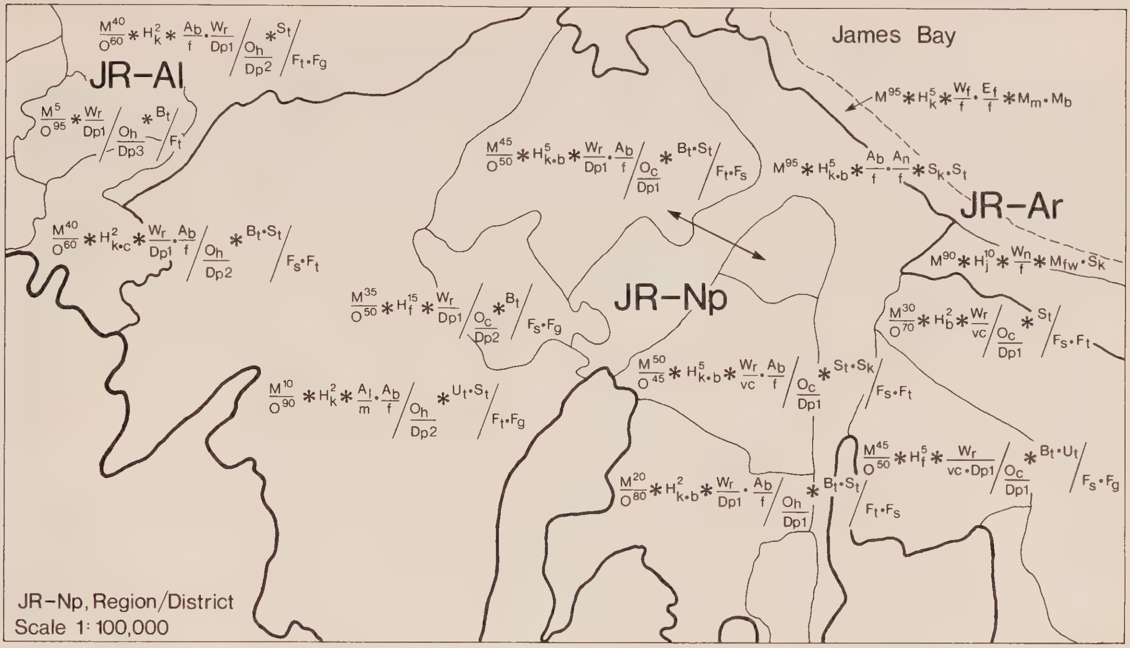
the Hudson Bay Lowland project is the Land System, although ground sampling is carried out at the Land Type level. Land Systems are initially delineated on 1:60,000 scale black and white panchromatic aerial photography and are subsequently transferred to 1:100,000 scale base maps. Map units are annotated following completion of the field work.

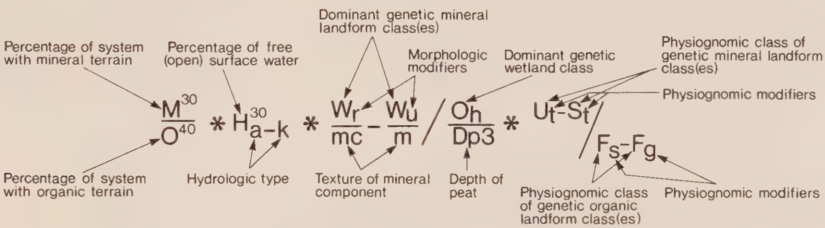
The annotation consists of four major components as follows:

$$\text{Relative Percentage of Mineral/Organic Terrain} * \text{Hydrologic Character} * \frac{\text{Genetic Mineral Land Form Class}}{\text{Genetic Organic Land Form Class}} * \frac{\text{Physiognomic Types/Upland}}{\text{Physiognomic Types/Wetland}}$$

The first component provides information on the percentages of mineral and organic terrain in the system. The second component deals with the percentage and nature of free surface water. The third major component provides information on the dominant genetic mineral landform and wetland classes. The last component describes the vegetation physiognomy on each of the mineral and organic terrain elements. The classification of the wetlands follows Zoltai et al, (1973) and Jeglum, Boissonneau and Haavisto,(1974). An example of the legend's application is given in Figure 5. An extended legend, designed to provide more detailed information on the dominant soil, landform and vegetation types is currently being prepared.

The composition of Land Systems are a function of the kind and distribution of Land Types and hydrological phenomena. Land Types in turn are a function of edaphic, vegetative, physiographic and hydrologic characteristics. Within the study area fifteen physiognomic types have been identified. These include: salt marsh, shallow and meadow freshwater marsh, graminoid fen, low shrub fen, treed fen, thicket swamp, conifer





<u>Physiography</u>

Genetic Mineral Landform Class

- W Marine
- A Alluvial
- E Estuarine
- R_c Bedrock, crystalline
- R_s Bedrock, sedimentary

Morphologic Modifiers

- r ridged
- j jigsaw
- u undulating
- p pitted
- f flats
- f_p flats with promontories
- f_b flats with beach
- s swale
- b bank (seasonally, permanently flooded)
- l levee
- n plain

<u>Genetic Wetland Landform Class</u>

- O Wetland

Morphologic Modifiers

- h horizontal
- p patterned
- p_{Bi} patterned with black spruce islands
- p_{pp} Patterned with incipient peat palsas
- h_{Bi} horizontal with black spruce islands
- h_{pp} horizontal with incipient peat palsas
- c confined
- r raised

<u>Texture of Mineral Terrain/Depth of Peat of Organic Terrain Deposits</u>

vc	very coarse	Dp1	.4-.8m
c	coarse	Dp2	.8-1.2m
mc	moderately coarse	Dp3	1.2-1.6m
m	medium	Dp4	1.6-2.0m
mf	moderately fine	Dp5	2.0-3.0m
f	fine		
vf	very fine		

<u>Hydrology</u>

Type/Abundance

- a Predominantly pools(<.5 ha)
- b Predominantly ponds(.5-1.0ha)
- c Predominantly lakes(>1.0ha)
- d Predominantly pools with ponds
- e Predominantly ponds with pools
- f Predominantly lakes with ponds
- g Predominantly ponds with lakes
- h Predominantly pools with lakes
- i Predominantly lakes with pools
- j Predominantly ponds with lakes and pools
- k Channelized floating water
- l Predominantly lakes with ponds and pools

<u>Vegetation</u>

Physiognomic Class

- B bog
- F fen
- M marsh
- S swamp
- U upland

Physiognomic Modifiers

- t treed
- s low shrub
- g graminoid
- o open
- f_e freshwater, emergent
- f_w freshwater, meadow
- b brackish
- m saline
- k thicket
- u sparsely/unvegetated
- x undifferentiated

Figure 5: Example of Land System Annotations from a part of the Port Albany map sheet.

Figure 3: Using LANDSAT imagery and automated classification techniques, various stages in the paludification of the HBL landscape can be effectively separated. This paludification sequence, moving inland from the coast can be generalized as follows: (1) Open water zone of James Bay; (2) Tidal flat/saltmarsh zone; (3) Freshwater marsh/sparsely vegetated ridge zone; (4) Thicket swamp/freshwater marsh zone - the effects of streams (4a) results in fingers of thicket swamp extending into zone 5; (5) Conifer swamp (Larix laricina) *on minor ridges with freshwater marsh/graminoid fen in inter-ridge areas; (6) Well developed beach ridge complexes with upland forest/treed bog* (Picea mariana) *on the ridges with small lakes and string fen/conifer swamp* (Larix laricina *and* Picea mariana) *in the inter-ridge areas; (7) String bog/string fen in mature peatland. Soil and vegetation gradients across these seven zones are outlined in Tables 2 and 3.*

Figure 4: Land Districts of the Southern James Bay - Hudson Bay Lowland Coastal Zone (three districts are described in Table 1).

(1) Ep: *East Point*
(2) Gb: *Gull Bay*
(3) Ms: *Missisicabi*
(4) Hb: *Hannah Bay*
(5) Hr: *Harricanaw*
(6) Kr: *Kesagami*
(7) Pn: *North Partridge River*
(8) Ps: *South Partridge River*
(9) Mf: *Moose Factory*
(10) Mr: *Moose River*
(11) Mo: *Moosonee*
(12) Lr: *Longridge*
(13) Np: *Nomansland*
(14) Ar: *Albany River*
(15) Al: *Fort Albany*

swamp, graminoid bog, low shrub bog, treed bog, sparsely vegetated shore ridges, upland thicket levée, upland forested levée and upland forested beach ridge. The first eleven are wetland types and the remainder are upland types. These physiognomic types are considered as being equivalent to Land Types.

Variation in the kind and distribution of Land Types, and hence among Land Systems, is caused by three main factors: (1) the geographic distribution of physiographic features, (2) the hydrological template, and (3) isostatic recovery of the land mass. The first two factors are common to the development of all peatland complexes. This last factor however represents an especially important and dynamic process affecting ecological succession in the Hudson Bay Lowland.

The present rate of uplift, which is between 1 and 1.5 m per century is one of the most rapid in North America (Webber, Richardson and Andrews, 1970). This has resulted in strong vegetation and soil gradients across the coastal zone from the active coast to the mature inland peat complexes. The differences in Land Types are therefore greatest in a direction perpendicular to the coast. It follows therefore that Land Systems trend parallel to the coast, their composition varying most strongly from the active coast inland.

The composition of Land Systems across the Coastal Zone is presented in Tables 2 and 3.

Table 2 illustrates the gradient occurring on poorly drained wetland sites (i.e. physiographically low areas such as swales and former tidal flats). Generally, the gradient is seen to be from the nutrient rich salt marsh through freshwater marsh and fen complexes nearest the coast and most recently emerged, to the nutrient poor bog complexes of the interior. The soil gradient shows a trend from saline gleysols on the coast, to humic gleysols in the freshwater marsh/fen complexes to mesisols and fibrisols in the deeper organic accumulations. The best drained sites (major beach ridges and levées) show a more typical boreal forest succession (Table 3). Soils grade from regosols to brunisols on the levées and from regosols to podzols on the beach ridges.

FUTURE WORK

The 1978 program will concentrate on developing the classification system for its application in the continuous permafrost zone of the Hudson Region. A section of the coastal zone centering on Winisk has been selected for study and field work will be carried out during the period 17 July to 14 August. An evaluation of radar imagery for wetland classification is also planned for 1978. Several test areas in the southern James Bay Region have been selected for study. The project is being conducted in cooperation with the Applications Division of the Canada Centre for Remote Sensing.

Systems	Physiognomic Type *	Characteristic Vegetation	Soils
(1) Shore Zone (2) Emergent Zone	Unvegetated and Saltmarsh	Puccinellia spp., Hippuris spp., Plantago maritima L., Salicornia europaea L., Carex paleacea Wahl., Triglochin maritima L., Cicuta maculata L., Scirpus spp., Eleocharis palustris (L.) R. + S., Juncus balticus Willd. (var. littoralis Engelm.)	Saline Gleysol
(i) Freshwater Marsh Systems	Freshwater Marsh	Menyanthes trifoliata L., Typha latifolia L., Salix spp., Carex spp., Hippuris vulgaris L., Equisetum fluviatile L., Petasites sagittatus (Pursh) Gray.	Rego Gleysol
	Thicket Swamp	Salix spp., Alnus rugosa (Du Roi) Spreng., Betula glandulifera (Regel) Gl., Myrica gale L., Carex spp.	Rego or Orthic Gleysol
(ii) Young Fen Systems	Graminoid Fen	Scirpus hudsonianus (Michx.) Fern., Carex limosa L., C. exilis Dewey, Menyanthes trifoliata L., Equisetum fluviatile, Rhynchospora alba (L.) Vahl., Scorpidium scorpoides (Hedw)	Terric Mesisol or Fibrisol (occasionally Gleysol)
	Low Shrub Fen	Betula glandulifera, Salix pedicellaris Pursh., Larix laricina (Du Roi) K. Koch, Carex interior Bailey, C. limosa, Myrica gale L., Sphagnum spp.	Terric Fibrisol or Mesisol (occasionally Gleysol)
(iii) Fen Systems	Graminoid Fen Low Shrub Fen Treed Fen	As above As above Larix laricina, Betula glandulifera, Carex spp., Sphagnum spp., Menyanthes trifoliata, Smilacina trifolia	As above + Typic Mesisol As above Typical Mesisol (Terric Mesisol)nearest to coast
(iv) Fen and young Bog Systems	Treed Fen Graminoid Fen Treed Bog	As above As above Picea mariana (Mill) B.S.P., Ledum groenlandicum Oeder., Chamaedaphne calyculata (L.) Moench., Sphagnum fuscum (Schimper) Klingr., Cladina spp.	Typic Mesisol Typic Mesisol Typic Fibrisol or Mesisol (Terric nearest to coast)

Increasing distance from coast

COASTAL ZONE BOUNDARY

* For mapping purposes Physiognomic Type corresponds to Physiognomic Group of Jeglum, Boissonneau and Haavisto (1974) except for Treed Fen and Treed Bog which correspond to the sub-Formation level.

Table 2 : Generalized Vegetation and Soil Gradients of Land Systems from the Coast to the Coastal Zone Boundary (Poorly Drained Sites).

Systems	Physiognomic Type	Characteristic Vegetation	Soils	
(1) Shore Zone (2) Emergent Zone	Unvegetated to partly Vegetated	Elymus mollis Trin., Artemesia tilesii Ledeb. (var. elatior T. + G.), Honkenya peploides (L.) Ehrh., Mertensia maritima (L.) S.F. Gray, Salix spp., Elaeagnus commutata Bernh.	Orthic Regosol Orthic Regosol	
	Upland Thicket Levee, Partly Vegetated, to Upland Forested Beach Ridge	Salix spp., Cornus stolonifera Michx., Picea glauca (Moench) Voss, P. mariana, Populus balsamifera L., P. tremuloides Michx., Shepherdia canadensis (L.) Nutt., Pleurozium schreberi (Brid.) Mitt., Hylocomium splendens (Hedw.)	Orthic Regosol (with young horizonation of Ae and Bh)	Increasing distance from coast
	Upland Forested Levee	Picea glauca, P. mariana, Populus balsamifera, Alnus rugosa, Pleurozium schreberi, Hylocomium splendens	Degraded Dystric Brunisol	
	Upland Forested Beach Ridge	Picea glauca, P. mariana, Populus balsamifera, Pleurozium schreberi, Hylocomium splendens	Orthic or Ferro Humic Podzols	
		COASTAL ZONE BOUNDARY		

Table 3: Generalized Vegetation and Soil Gradients of Land Systems from the Coast to the Coastal Zone Boundary (Well Drained Sites, Beach Ridges and Major Levées).

REFERENCES

Andrews, J.T. 1969. The pattern and interpretation of restrained postglacial and residual rebound in the area of Hudson Bay, N.W.T., Canada. Geol. Surv. Can. Paper 68-53. pp.49-62.

Canada Committee on Ecological Land Classification (CCELC). 1977. Newsletter No. 2. (ed. by E. Wiken) Lands Directorate Environment Canada, Ottawa, 4 p.

Haworth, S.E., D.W. Cowell and R.A. Sims. 1978. Bibliography of published and unpublished literature on the Hudson Bay Lowland. Can. For. Serv., Sault Ste. Marie, Ontario, Information Report O-X-273. 270 p.

Jeglum, J.D., A.N. Boissonneau and V.F. Haavisto. 1974. Toward a wetland classification for Ontario. Can. For. Serv. Sault Ste. Marie, Ontario. Information Report O-X-215. 54 p. plus appendices, illus.

Jurdant, M., J.L. Belair, V. Gerardin and J.P. Ducruc. 1977. L'inventaire du Capital-Nature. Service des Études Écologiques Régionales, Environnement Canada, Ste. Foy, P.Q. Ecological Land Classification Series No. 2, 202 p.

Sanford, B.V., A.W. Norris and H.H. Bostock. 1968. Geology of the Hudson Bay Lowlands (Operation Winisk). Geol. Sur. Can. Paper 67-60. 118 p. and maps.

Subcommittee on Biophysical Land Classification. 1969. Guidelines for Biophysical Land Classification. Can. For. Serv. Publ. No. 1264, Environment Canada, Ottawa. 61 p.

Webber, P.J., J.W. Richardson and J.T. Andrews. 1970. Post glacial uplift and substrate age at Cape Henrietta Maria, southeastern Hudson Bay, Canada. Can. J. Earth Sciences 7: 317-325.

Zoltai, S.C., F.C. Pollett, J.K. Jeglum and G.D. Adams. 1973. Developing a wetland classification for Canada. *in* Proc. 4th North American Forest Soils Conference, Laval University, Quebec. pp.497-511.

ENVIRONMENTAL FACTORS IN THREE REGIONAL PLANNING STUDIES

P. J. Denison
Acres Consulting Services Limited
Niagara Falls, Ontario

ABSTRACT

The environmental factors that were incorporated into the preparation of long-range (uear 2000) development plans for three large regions of southern Ontario are summarized. The study regions were the Lake Ontario waterfront and related inland areas of Halton and Wentworth Counties, Simcoe County and Lambton County.

RÉSUMÉ

Les facteurs d'environnement considérés dans l'établissement des plans d'aménagements à long terme (l'an 2000) pour trois grandes régions du sud de l'Ontario sont donnés en résumé. Les régions à l'étude comprenaient les terrains en bordure du lac Ontario, et les territoires intérieurs adjacents des comtés de Wentworth, Halton, Simcoe et Lambton.

INTRODUCTION

Those environmental considerations that constrained the long-term planning for three geographically and physically diverse regions of southwestern Ontario are briefly described. The paper was originally presented at the ACEC Conference - Environment II, September 1976.

The first project, carried out by a consortium of Acres Consulting Services and Project Planning Associates, produced the report *The Halton-Wentworth Waterfront Study* in June 1974. As the title implies, a long-range conceptual plan was developed for the Lake Ontario shorelines and related land areas of Halton and Wentworth counties. The project was funded by the Halton Region and Hamilton Region Conservation Authorities and the Ontario Ministry of Natural Resources, Conservation Authorities Branch. It was monitored by a coordinating committee and a technical advisory committee representing provincial, municipal and township levels of government, local authorities and other organizations directly concerned.

The second project, carried out by Hedlin Menzies and Associates Underwood McLellan and Associates, Earl Berger Limited and Acres Consulting Services, produced the report *"Simcoe-Georgian Area Development Strategy Study"* in February 1976. This report presented a long-range strategy for locating alternative levels of population and industrial growth in Simcoe County. Funding was by the Department of Treasury Economics and Intergovernmental Affairs; monitoring was by the Simcoe-Georgian Task Force composed of political and technical advisory committees representing provincial, municipal and township levels of government, local authorities and other concerned organizations.

The third project, carried out by a consortium of Hedlin Menzies and Associates and Acres Consulting Services, resulted in the report *Sarnia Lambton Area Planning Study* in May 1976. The study was funded by the Department of Treasury, Economics and Intergovernmental Affairs and was monitored by a steering committee comprised of provincial and township representatives.

Each of these projects included an extensive public participation program; and the reports, including appendix and reference material, are several hundred pages long. Only examples of some of the study components that related directly to environmental concerns are given here.

HALTON—WENTWORTH WATERFRONT STUDY

In the course of developing planning guidelines for that area of the Lake Ontario waterfront extending from the Oakville-Mississauga boundary through Burlington, Dundas, Hamilton and Stoney Creek to the boundary with the Regional Municipality of Niagara (Figure 1), a number of environmental concerns were identified and elaborated upon. These were reported on in working papers covering limnology, hydraulics, hydrometeorology, geology, erosion and shoreline protection, water quality, air quality and biology.

The environmental working papers were integrated by the planning coordinators with additional working papers covering landscape, land use and planning, economic, industrial and demographic predictions, recreation, history, infrastructure, marine and harbor public administration and finance, and public participation. The product, a concept for waterfront development, is shown in Figure 2.

Following are some examples of particular conditions that were analyzed in the environmental working papers:

Near-Shore Current, Water Temperature and Water Quality

Near-shore currents are primarily wind driven from the south through southwest to west directions during the summer months. The major sources of polluted water that affected the Lake Ontario shores in the study area in 1974 were the discharge through the Burlington Ship Canal of water from Hamilton Harbour and the discharge from three small sewage treatment plants along the Burlington-Oakville shoreline. Other sources of pollution were septic tanks on the Hamilton-Burlington beach strip and on the Saltfleet shoreline east of Stoney Creek, and the Grimsby sewage treatment plant. Water leaving the Burlington Canal is, for the most part, carried northeastward along the Burlington-Oakville shore as are the discharges from the sewage treatment plants in that area.

This leaves a condition of relatively good quality water along the Hamilton beach strip and Saltfleet shores under the influence of westerly winds on warm summer days when swimming demand is high. Under these same wind conditions, near-shore water temperatures are relatively mild for Lake Ontario. Opportunities for water-based recreation were recommended for development in this area.

Shoreline Erosion and Protection and the Beach Strip

Lake Ontario levels in 1973 - 1974 were near the recorded high values. A few intense storms moving over or just south of the lake produced strong easterly winds along the main axis of the lake and caused serious erosion in the study area from lake setup and wave action. The shores of the study area were surveyed by boats, and where possible by walkover, to identify locations of major erosion and to evaluate the effectiveness of protective works placed by individual owners. Added protection was recommended for some of these areas in the form of man-made offshore island that could serve dual purposes for marina developments and other recreational uses.

These conditions compounded a number of problems for residents on the Burlington-Hamilton beach strip, the only major sand beach in the area. These included the flooding of basements and malfunction of septic tanks. These houses are also immediately downswind, for the prevailing west and southwest directions, of the heavy industries on Hamilton-Harbour, and are intermittently exposed to relatively high air pollution levels.

For these reason, and because the extensive sand beach represents a unique resource in the study area, it was recommended that the entire lakeside stretch of the strip be turned into recreational use, by gradually acquiring properties as they become available in time.

Fish and Wildlife Areas

Figure 3 shows eight areas recommended for preservation or development as fish and wildlife reserves. These include the bird and wildlife sanctuary; Cootes Paradise adjacent to the Royal Botanical Gardens at the western end of Hamilton Harbour; the marsh areas at the lower ends of Redhill, Grindstone and Bronte creeks; the lower end of Oakville Creek; the Stoney Creek ravine; and the man-made ponds in the Hamilton Region Conservation Authority park at Fifty Point.

SIMCOE-GEORGIAN AREA DEVELOPMENT STRATEGY STUDY

Simcoe County has for many years served as holiday grounds for Torontonians, particularly on Lake Simcoe and Georgian Bay. More recently, the southern and central regions of the county have experienced population growth pressures to a considerable extent from people commuting to work in Toronto. The objective of this study was to examine alternative levels of population growth that may take place and suggest distributions of that population in patterns compatible with the desires of existing residents, protection of environmentally sensitive areas and historical sites, retention of prime agricultural land in food production, and maintenance and development of recreational areas. Figure 4 shows the study area.

Those areas rated as environmentally sensitive on a scale from 1 (very sensitive) to 3 (sensitive) where population growth may occur are shown in Figure 5. The nature of the

concern is classed as forest, water quality, fish, waterfowl, ungulates, other game, and shore stability. Historical sites, such as Martyr's Shrine near Midland, were dealt with separately, as was the capacity of both Lake Simcoe and Georgian Bay to assimilate increased population and industrial wastes. Several areas of major environmental concern provided constraints on the planning process. These included Nottawasaga River basin with prime fish spawning areas along its main branch and tributaries running south from Georgian Bay to beyond Alliston; the eastern headwaters of the Nottawasaga containing the biologically unique Miniesing Swamp to the west of Barrie; the wildlife habitats of the Wye Marsh areas near Midland; and the fish spawning in Pretty and Batteaux Rivers east of Collingwood.

Figure 6 shows population ranges which are considered the upper limits to growth that could be distributed within the county without major damage to the existing environment. The total of the highest figures in each range comes to about 3/4 of a million; a more modest growth rate was recommended for other reasons.

Figure 7 shows the agricultural soil capability of the county, much of which is Class 1 and Class 2 land. Figure 8 shows the recreational capability both on the shoreline and upland in the county.

All of these constraints, together with analysis of water supply and waste disposal capacities, were combined to produce recommended population levels and distribution patterns shown in Figure 9.

SARNIA-LAMBTON AREA PLANNING STUDY

The objectives of this project were similar to those for the Simco-Georgian study. Figure 10 shows that Lambton County is intermittently industrialized from Sarnia southward along the St. Clair River; the remainder of the county is primarily in farmland, with recreational areas and parkland along the Lake Huron shoreline.

Figure 11 shows environmentally sensitive areas of the county rated on a scale of 1 (sensitive) to 3 (very sensitive). The nature of environmental concerns are classed as vegetation (both floral and wooded), water (both wintering and migratory), reptiles, breeding terrestrial birds, sand dune ecology, and small mammal habitat. One species of reptile, the Butler garter snake, is found in few other areas of southern Ontario and the numbers are declining.

In general, several shore locations, including the sand dunes on Lake Huron, the Sydenham River basin in the south central region and the Ausable River basin in the northeast region of the county, were considered as constraints on the location of new populations and industries.

Figure 12 shows the recreational capability of the county to be heavily oriented to the St. Clair River and Lake Huron shorelines. Figure 13 shows the agricultural capability, much of which is Class 1 and Class 2.

Figure 14 shows sulfur-dioxide contours on similar days in May 1973 and 1975. As can be seen, when the winds blow up or down the valley, as is frequently the case, air pollutants from the several American and Canadian sources in that region tend to add to each other along a relatively narrow area inland from the St. Clair River. Relatively clean air is found over the inland areas of the county and along the Lake Huron shore. Air quality considerations favor the location of large new populations away from the river valley.

Combining environmental, recreational and agricultural considerations with analysis of water supply, sewage treatment and transportation facilities and requirements, the general development strategy shown in Figure 15 emerged.

REFERENCES

Acres Consulting Services and Project Planning Associates, 1974. The Halton-Wentworth Waterfront Study.

Hedlin Menzies and Associates, Underwood McLellan and Associates, Earl Berger Limited and Acres Consulting Services. 1976. Simcoe-Georgian Area Development Strategy Study.

Hedlin Menzies and Associates, Underwood McLellan and Associates and Acres Consulting Service. 1976. Sarnia-Lambton Area Planning Study.

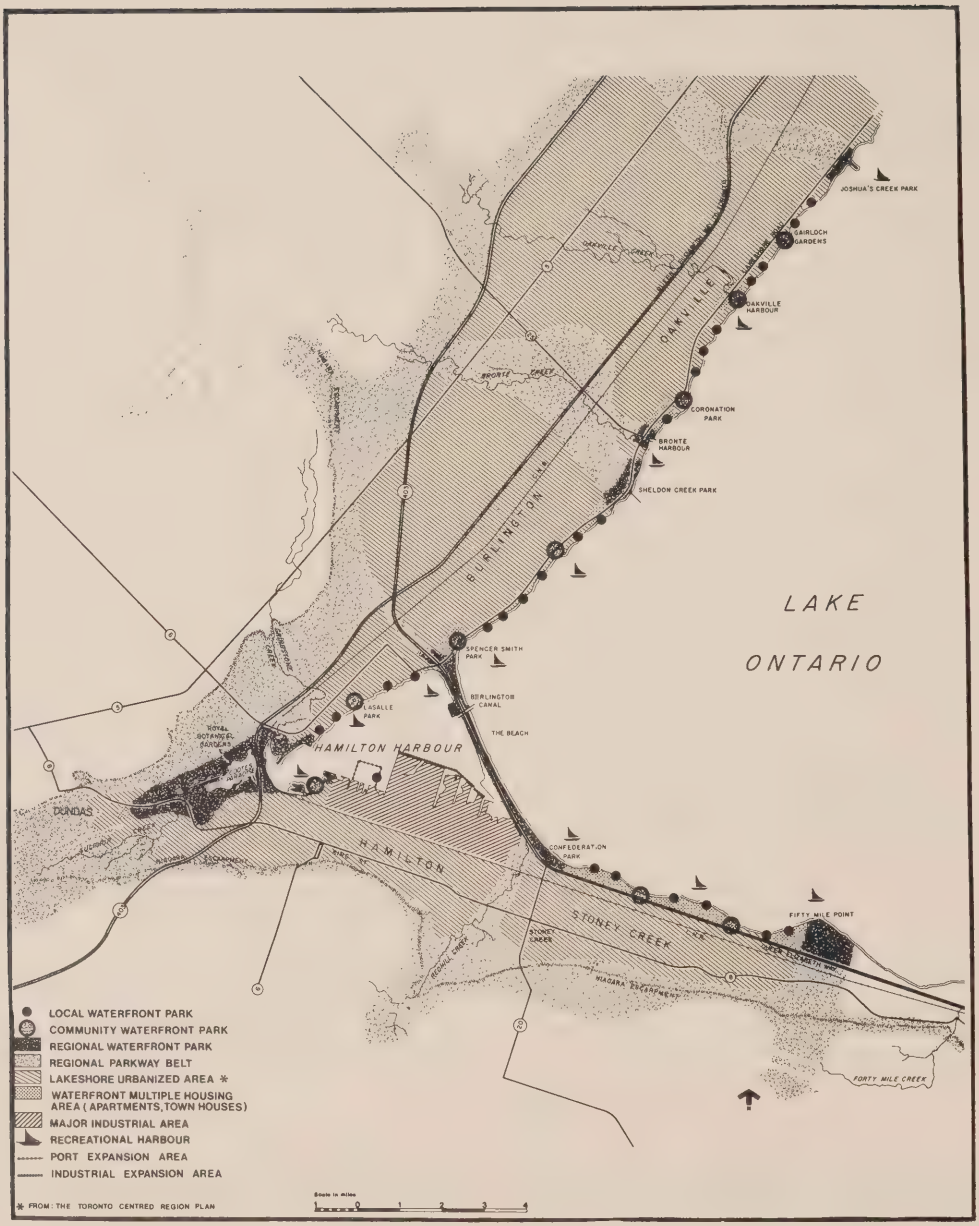


Figure 1: Halton-Wentworth Study, Goals Plan

Figure 2: Halton-Wentworth Waterfront Land Use Concept

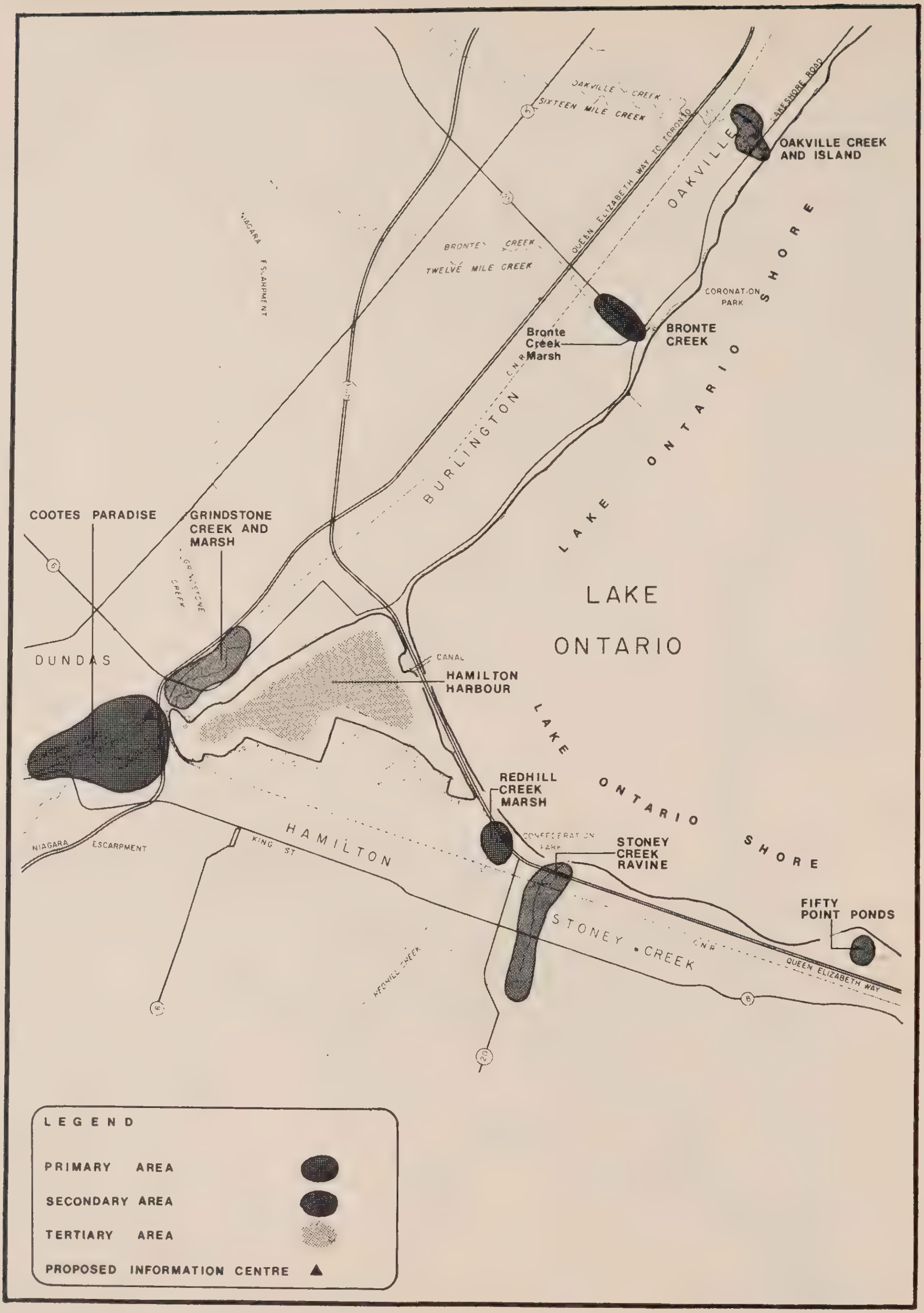


Figure 3: Halton-Wentworth Waterfront Fish and Wildlife Areas

Figure 4: Simcoe-Georgian Area Task Force Study Region

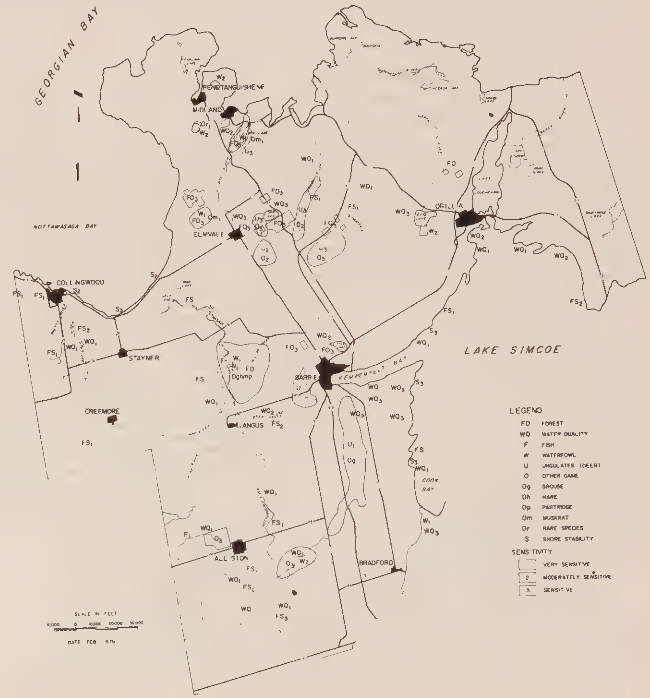


Figure 5: Simcoe-Georgian Environmentally Sensitive Areas

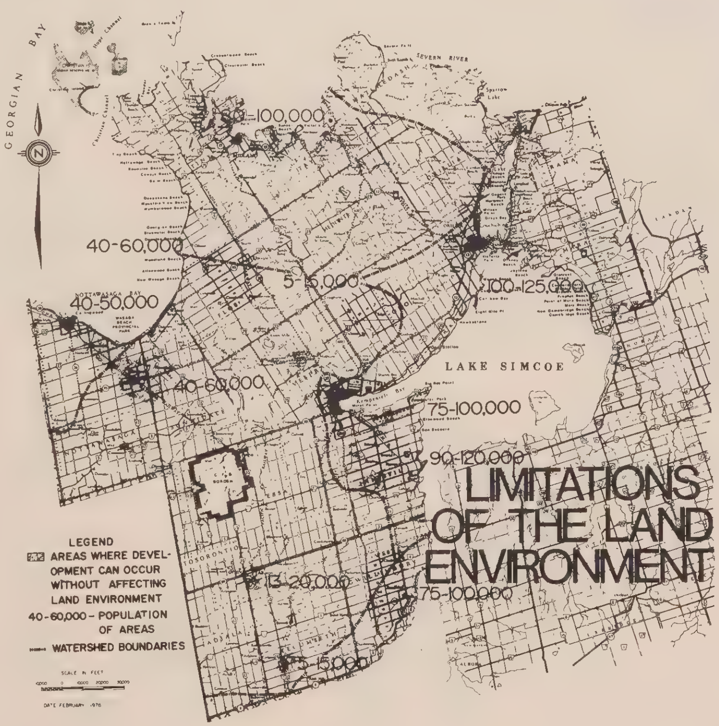


Figure 6: Limitations of the Land Environment in the Simcoe-Georgian Area

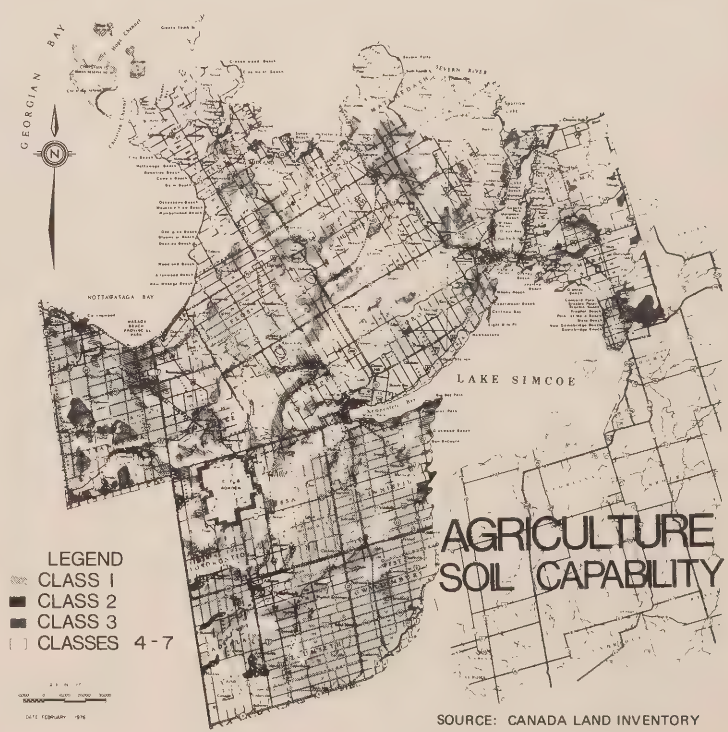


Figure 7: Soil Capability for Agriculture in the Simcoe-Georgian Area

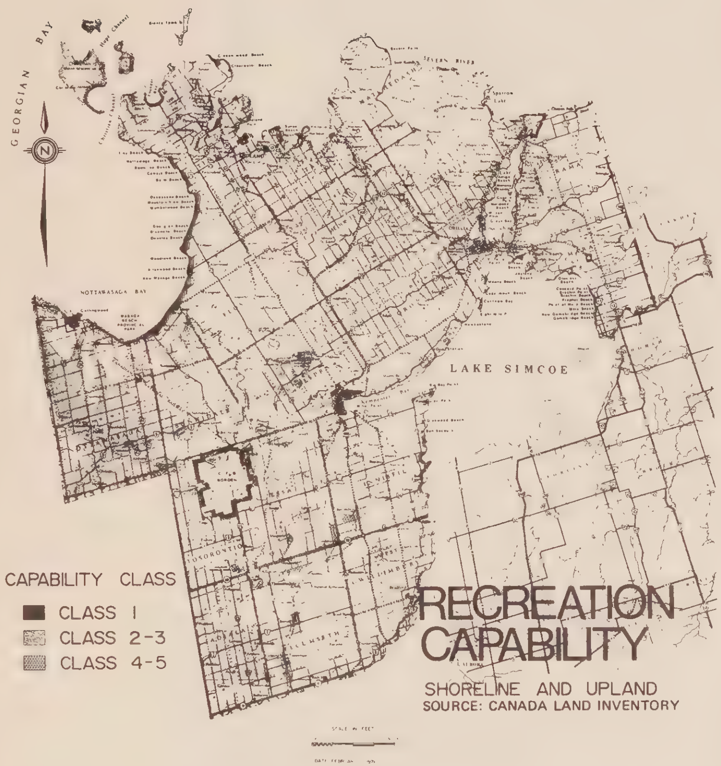


Figure 8: Land Capability for Recreation in the Simcoe-Georgian Area

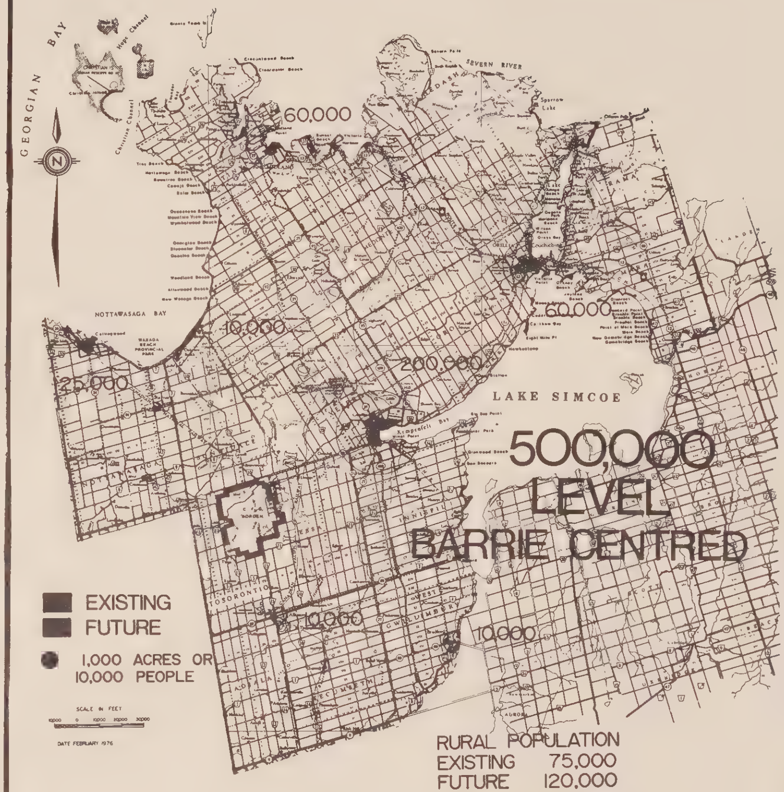


Figure 9: Barrie Centred 500,000 Population Projection, Simcoe-Georgian Area

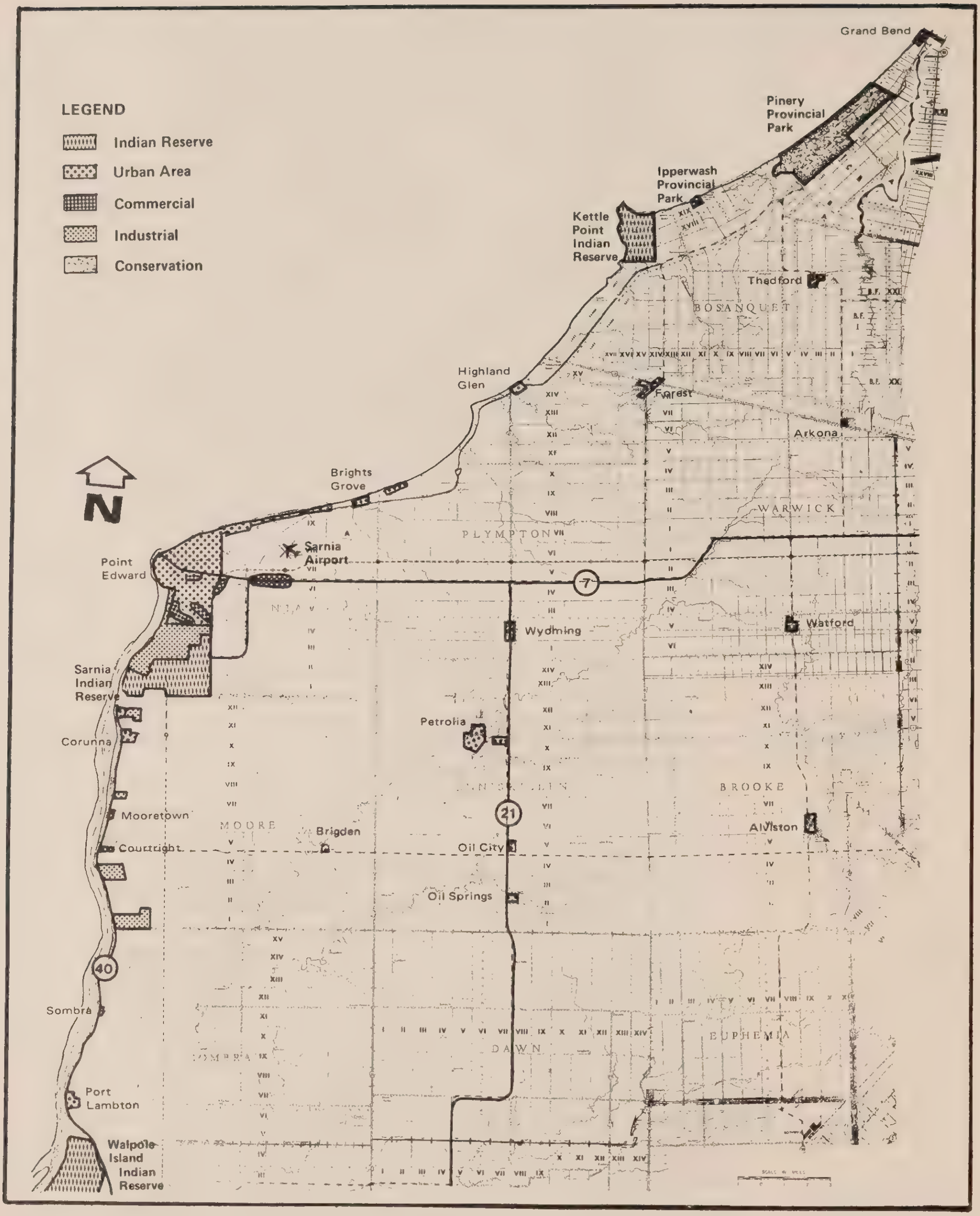


Figure 10: Existing Land Use in the Sarnia-Lambton Study Area

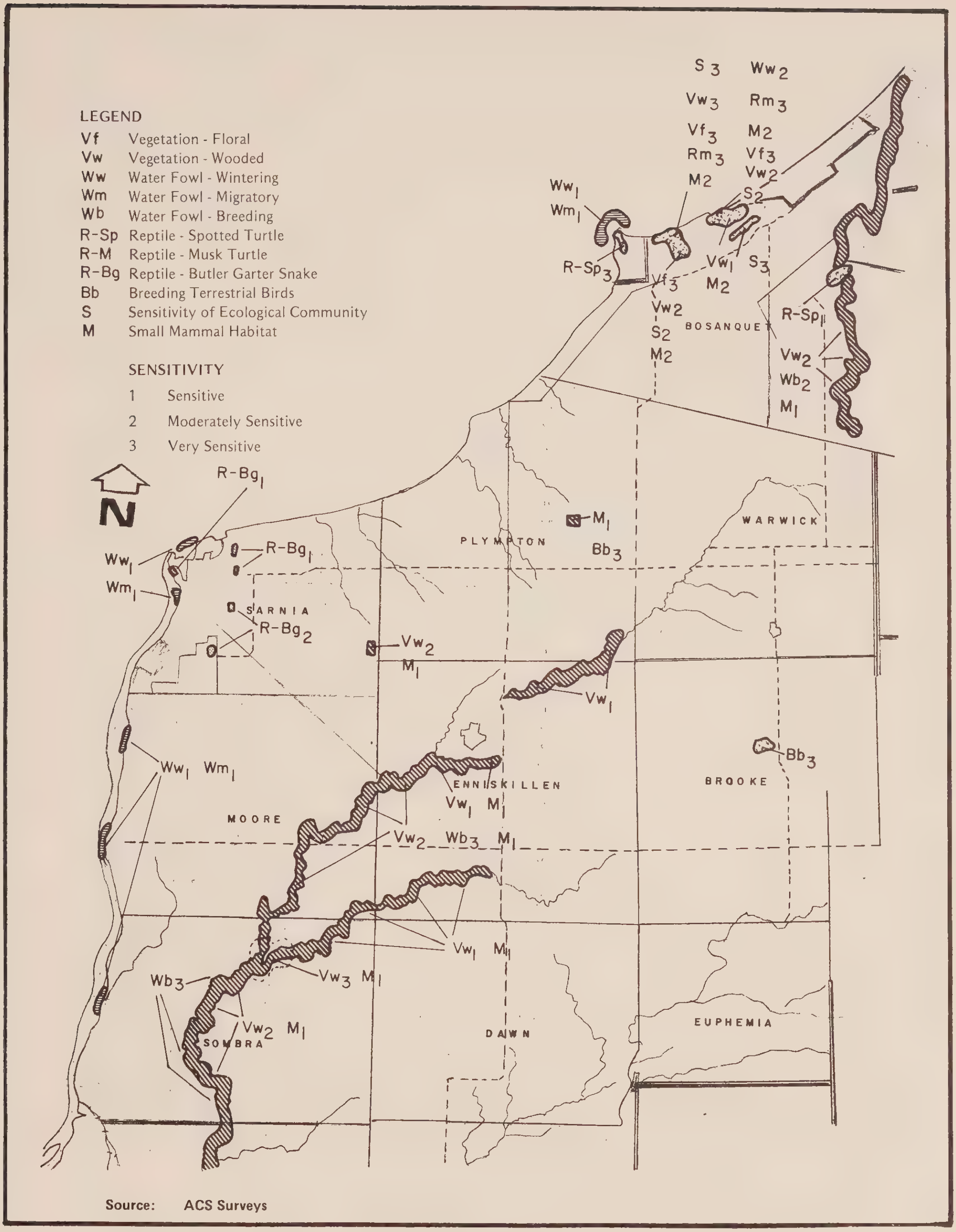


Figure 11: Environmental Considerations for the Sarnia-Lambton Study Area

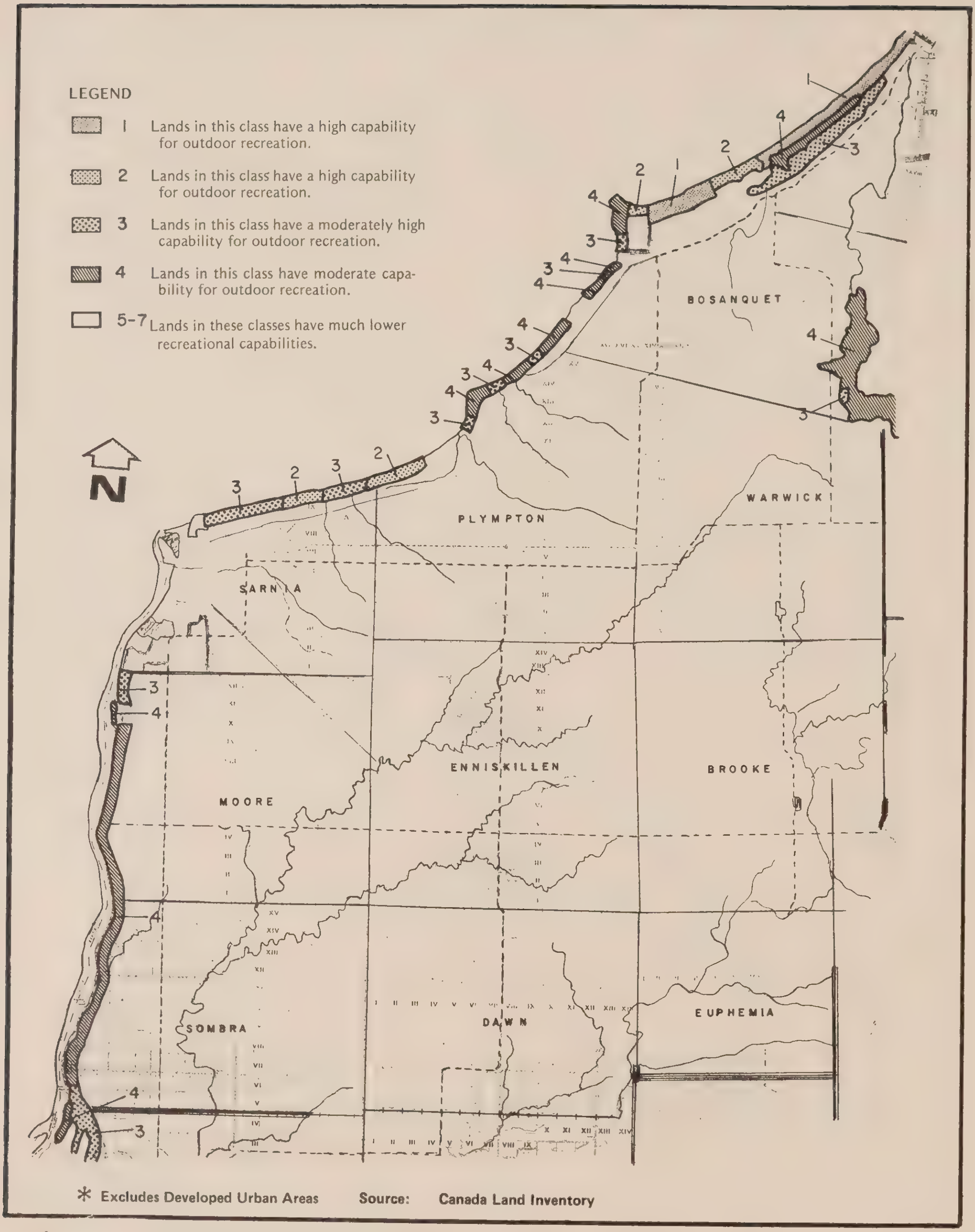


Figure 12: Land Capability for Recreation in Sarnia-Lambton Area*

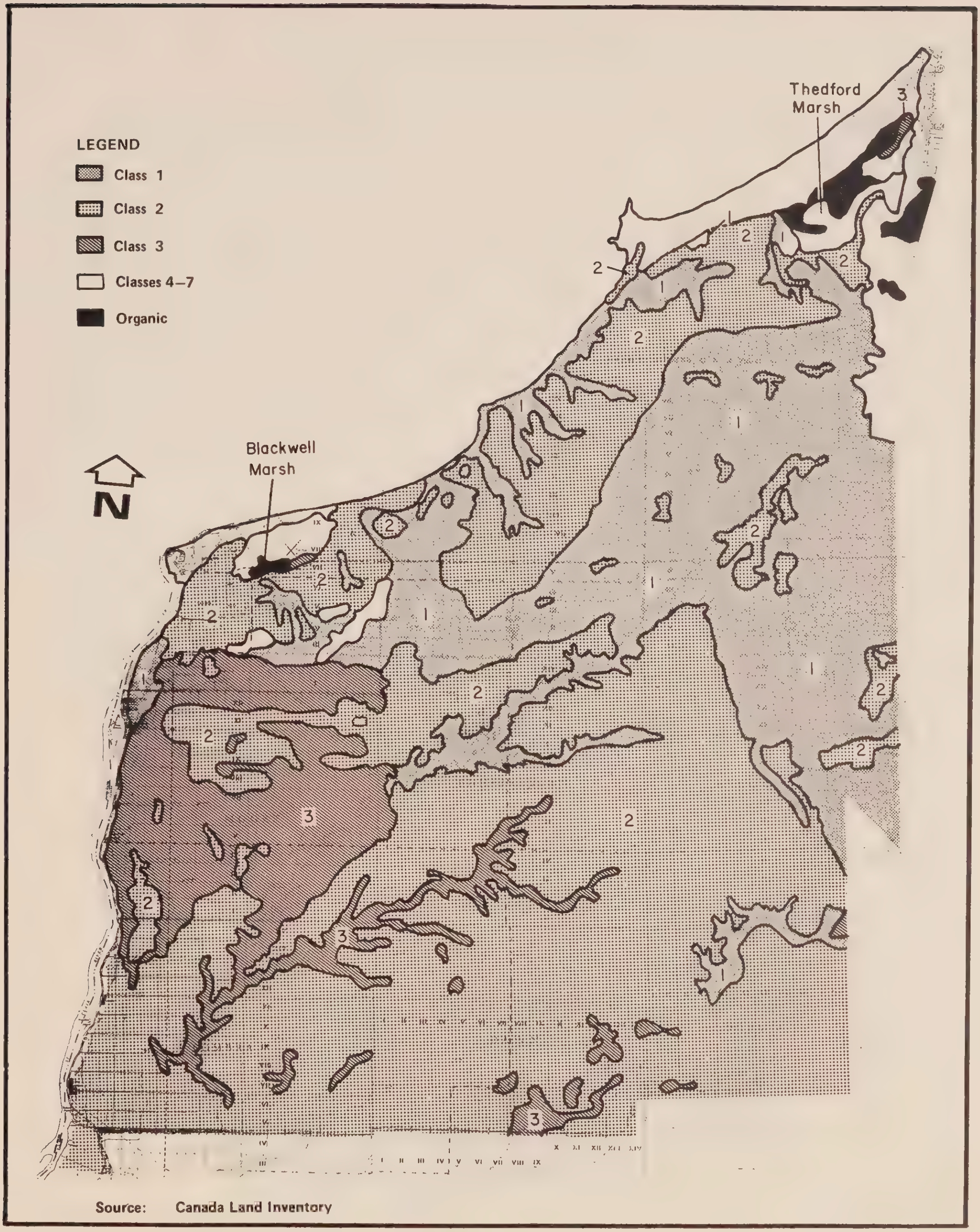


Figure 13: Land Capability for Agriculture in the Sarnia-Lambton Area

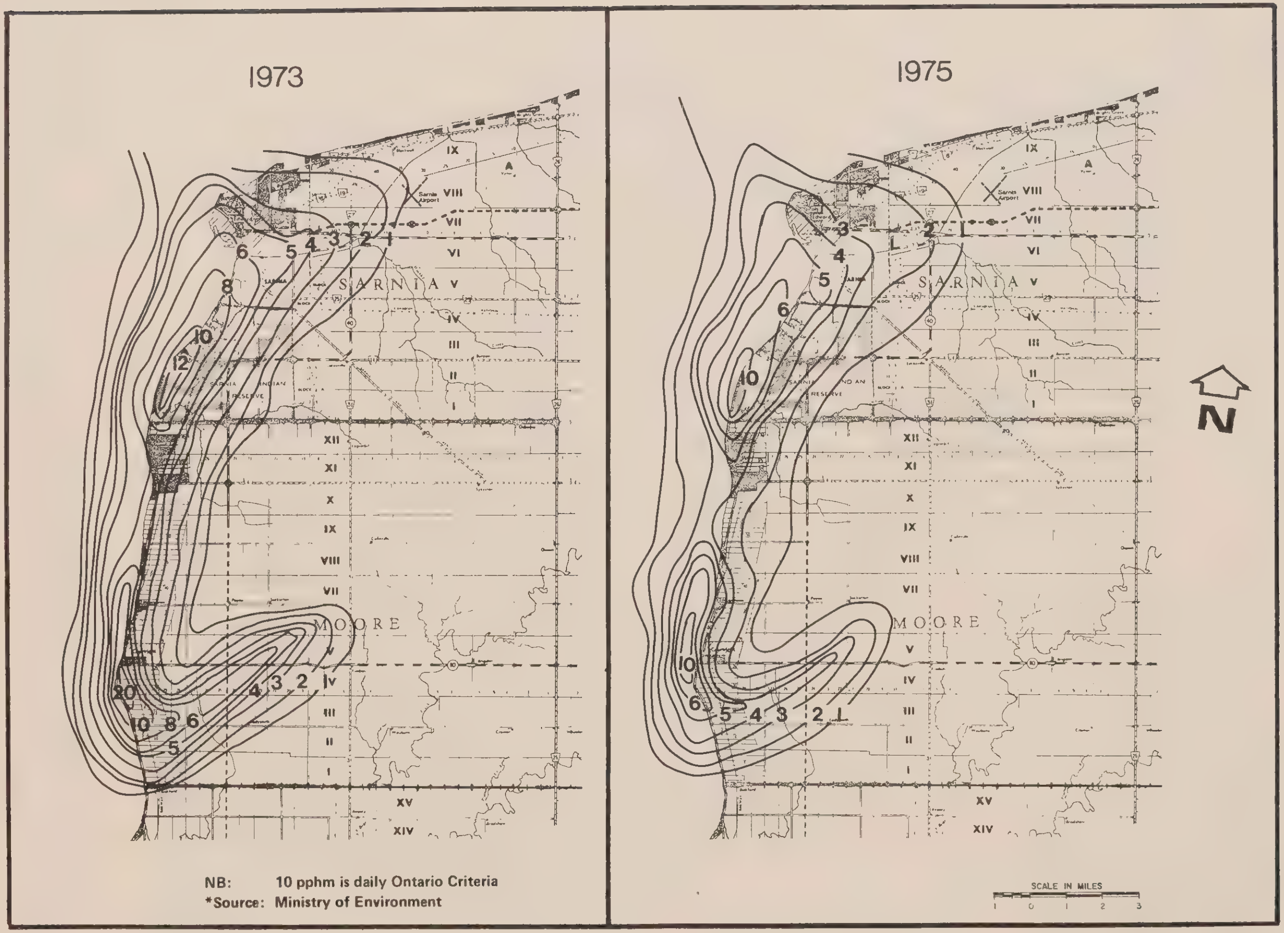


Figure 14: Changes in SO_2 Aerosol Concentrations in Sarnia-Lambton Area 1973-1975

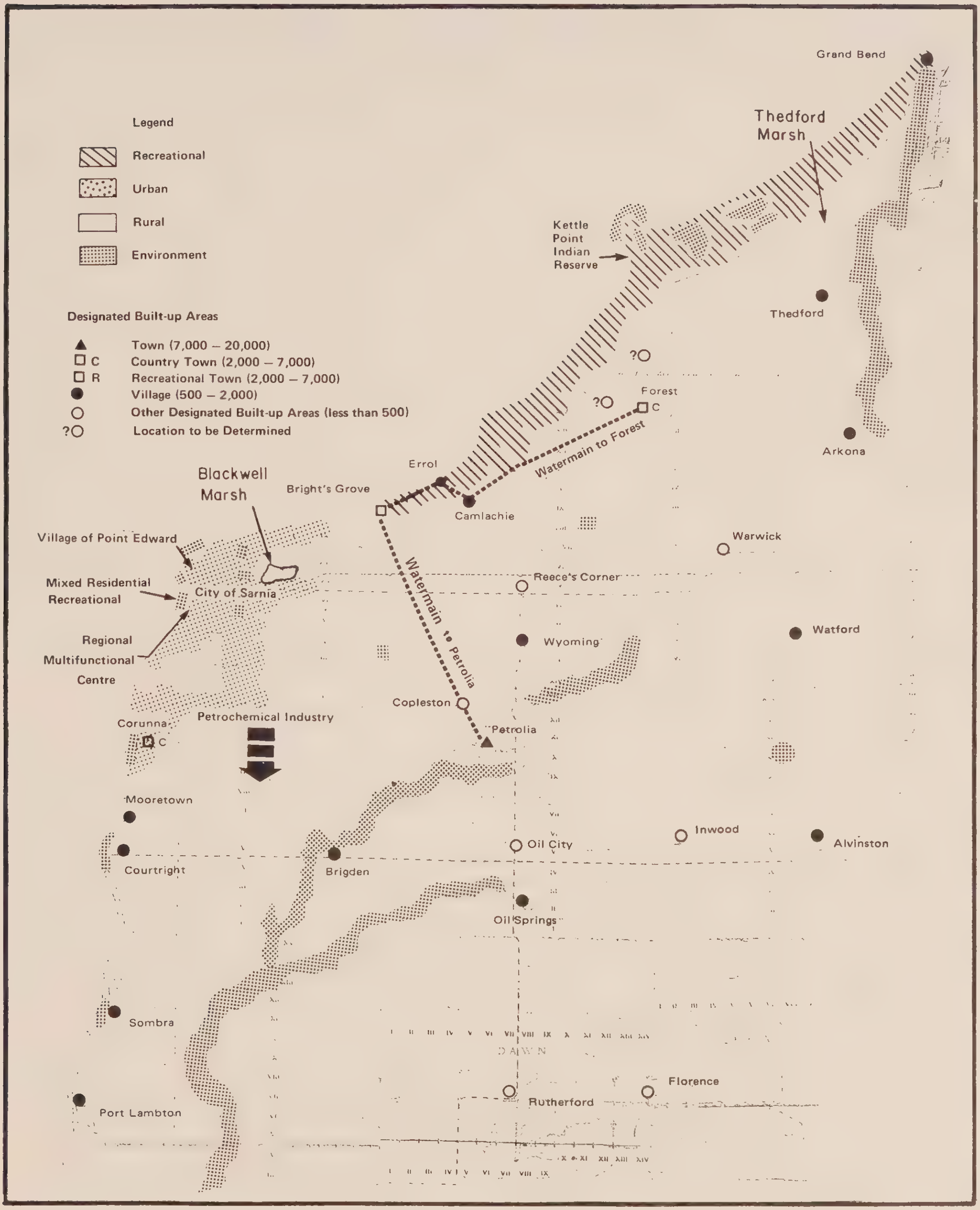


Figure 15: General Development Srategy for the Sarnia-Lambton Planning Area

MAJOR APPLICATIONS OF ECOLOGICAL LAND INVENTORY AND CLASSIFICATION IN QUEBEC*

J. P. Ducruc
Service des Études Écologiques
Régionales
Environnement Canada
Québec, Québec

INTRODUCTION

In general, this paper summarizes the text presented by Jurdant and Gerardin (1977) at the Symposium on Ecological Classification of Forest Land in Canada and Northwestern USA held in Vancouver in October 1977. However, we will present here, only the applications of the ecological inventory and classification already in existence in Quebec. We will not consider the application (the most numerous and complete) used by the James Bay Development Corporation and by the James Bay Energy Corporation in the James Bay hydroelectric project, which will be presented during this meeting.

ECOLOGICAL INVENTORY AND CLASSIFICATION IN QUEBEC

Brief History

Prior to base studies which led to the preparation of the Canadian Land Inventory (CLI) maps, ecological inventories in Quebec were focused on soils in agriculture and on vegetation in forestry. The elaboration of the maps for the CLI stimulated a demand for more systematic base line studies and a deeper understanding of the necessity for Quebec to adopt a uniform ecological inventory and classification system. In 1972, the Forestry Research and Development Council established the Committee for Ecological Application in Territory Management which, in turn, formed the Sub-Committee for Ecological Application in Territory Management. It was, in fact, a regrouping of specialists working in this field in Quebec, their main objective was to recommend a uniform land classification methodology. In 1975, the Sub-Committee presented a report on methodological concepts for land classification which was published in the following year by Jurdant et al, (1976a).

This report recommended to the Quebec Government that they make a systematic land classification of the whole province. Covering an average of 75 000 km^2 per year, the duration of the program was estimated to be 20 years with annual expenses (in \$ 1975) of \$1 million. This program would be carried out by a central agency made up of specialists working in this field (drawn from provincial and federal departments and universities). This organization, for which the name 'Ecological Mapping Institute' had been proposed, would be operated under the jurisdiction of the already existing Quebec Planning Development Bureau.

Unfortunately, in March 1978, there is still no central organization in Quebec, neither to carry out nor to coordinate such a program of land classification. The inventories are still being done ad hoc except for the Lands and Forests Department and Environment Canada where these studies conform to the methodological concepts established by the Committee for Ecological Application in Territory Management.

Status of Inventories (March 1978)

It is understood that we can refer only to the inventories known to us, which are based on *Methodological concepts for the ecological inventory and classification of Quebec* (Jurdant et al, 1976a).

Department of Lands and Forests:

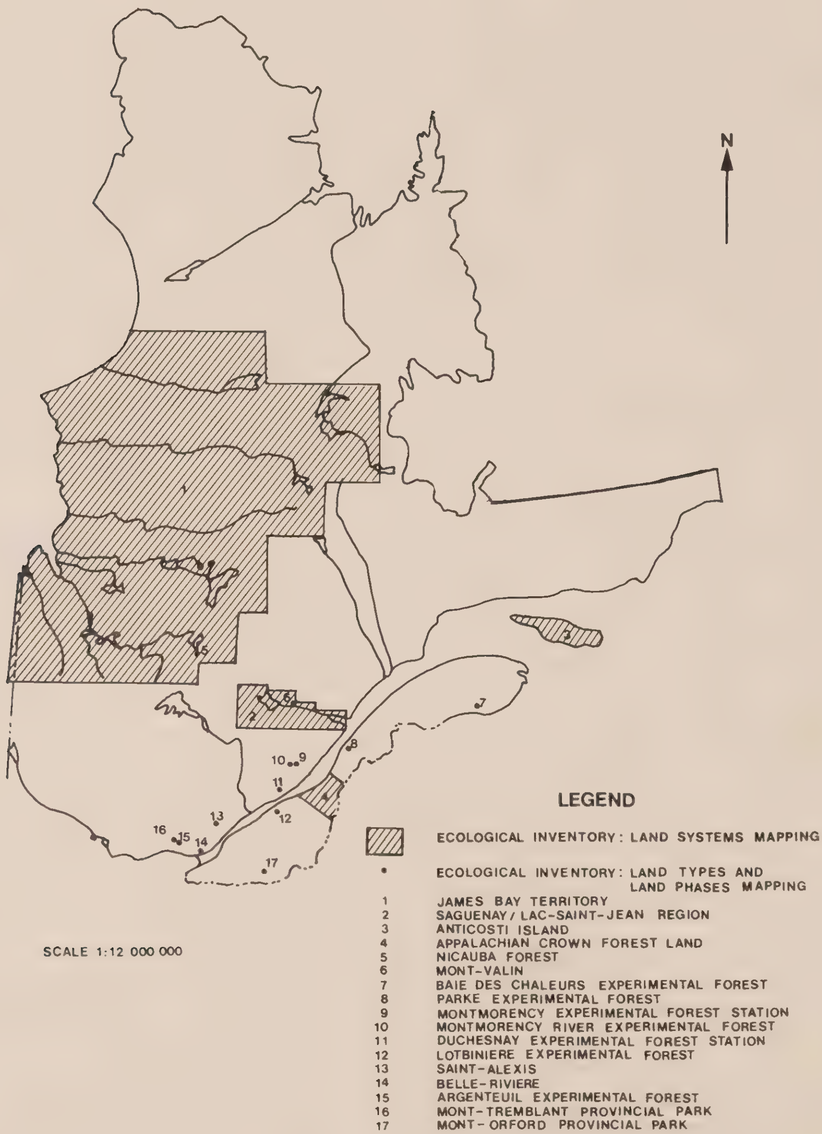
The Research Service of this Department has undertaken an ecological inventory program to map, at a large scale, Forest Research Stations at the land phase level and/or at the land type level (Carrier et al, 1976; Majcen and Gagnon, 1976) as outlined on Figure 1.

At the same time, this Service also has a program for mapping land systems at the scale of 1:125 000 in the Appalachian Region as well as a program for defining land regions for Southern Quebec.

The Land Management Service has also initiated a detailed ecological inventory of the Ecological Reserves at the land phase level and/or at the land type level (Filion and Blouin,

*Abstract/Résumé on/à page 199.

FIG 1. ECOLOGICAL INVENTORIES STATUS IN QUEBEC (from Jurdant and Gerardin, 1977)



1977a, 1977b).

They also have mapped the land systems at Anticosti Island with the objective of elaborating the basic management schema.

Department of Tourism, Fish and Game:

Parks Directorate has initiated an ecological mapping program for the Mont-Orford Provincial Park as well as a description of its biophysical potential in relation to future management, outdoor recreation activities and a preliminary plan for a nature interpretation centre (Pouliot and Provencher, 1977). The park will be mapped at a scale of 1:10 000 at the land type level.

Environment Canada:

The Service des Etudes Ecologiques Régionales (SEER) has, for its part, undertaken ecological inventories at various levels:

- land phase mapping (scale 1:8 000) of the Nicauba Experimental Forest (Jurdant and Frisque, 1970),

- land type mapping (scale 1:4 000) of the Montmorency Experimental Forest (Jurdant, 1964),

- land type mapping (scale 1:5 000) of the interpretation center at Belle Rivière (Bélair and Ducruc, 1977),

- land type mapping (scale 1:15 000) of the Mont-Valin (Jurdant et al, 1972a),

- land system mapping (scale 1:125 000) of the Saguenay/Lac-Saint-Jean Region (Jurdant et al, 1972b) and of the James Bay municipality (Jurdant et al, 1976b).

UTILIZATION OF ECOLOGICAL INVENTORIES AND CLASSIFICATIONS

Zoning

Owing to the interpretation concerning the potential of renewable resources, the developers in collaboration with ecologists, can recommend specific land-uses for each unit. Therefore, zoning is possible. Despite the urgency for such zoning and despite the numerous electoral promises, Quebec is not endowed with a general policy of zoning.

The municipality of St. Fulgence in the Saguenay Region, in collaboration with the Municipal Affairs Department of Quebec, has established a zoning plan based on the map of land systems and the classification of land types which was produced by Jurdant et al, (1972b). The criteria used were erosion hazards, engineering potential, topography, recreation potential of the water bodies and landscape attractiveness.

In 1974, the Lands Management Service of the Lands and Forests Department of Quebec established a management plan for Anticosti Island. Data based on an ecological inventory were kept in a data bank from which a series of interpretative maps were automatically produced. Analysis of the results led to management decisions for the island.

At present, James Bay Development Corporation is responsible for the most important management plan in Quebec. They are in the process of elaborating this plan and they are making maximum use of the inventory and classification data. The paper presented by Gantcheff, Normandeau and Glaude (1979) at this meeting clearly indicates this process.

Forest Management

Reforestation planning:

In the Saguenay/Lac-Saint-Jean region, the Lands and Forests Department is planning its reforestation operations by using the ecological inventory data. While considering where and which species to replant, the foresters are aware of a series of factors which can be interpreted from the ecological map; those considering the choice of species compared to the soil characteristics of the site to be reforested:

- soil location for different species of trees,

- planting difficulties,

- natural regeneration potential,

- aggressive species on disturbed sites or after fire,

- trafficability,

- complementarity and/or compatibility levels with other natural resources such as agriculture, landscape attractiveness, etc.

Choice of silvicultural treatments:

The land type mapping of a county in the Lac-Saint-Jean area, allowed the foresters of the Lands and Forests Department to define sites which were favorable for precommercial cutting, regeneration cutting and for commercial cutting. In addition, the knowledge of the most productive species for a given land type permitted

them to recommend silvicultural treatments which would favor the regeneration of these species.

At present, the Lands and Forests Department is using the ecological map of the James Bay Territory to establish a biophysical profile for the management unit of Matagami and Chibougamau. A management unit is an administrative unit subdivided into areas according to physical limits (waterways, roads, etc.) and/or forest stand limits. The foresters have superimposed the limits on the land systems map; they have reevaluated the distribution of land types in their units based on the land systems map. Despite the inherent difficulties of this method, they are able to reevaluate very quickly certain ecological characteristics in these units: the type of surficial deposits, drainage classes and forest potential. Based on these data, they can recommend the most appropriate silvicultural treatments and determine areas to reforest.

Selection of Intensive Management Areas

Agriculture:

The Quebec Department of Agriculture, in collaboration with the SEER has defined the kind of crop best suited to each land type in the Saguenay/Lac-Saint-Jean Region.

Recreation:

A study for the development of the Pointe-Taillon Regional Park, (Discuteanu et al, 1974) requested by the Parks Service of the Tourism Fish and Game Department, is totally based on the analysis of the land systems map of the Saguenay/Lac-Saint-Jean. A subjective analysis of the landscapes and an updated vegetation map were the only elements added to the baseline data in developing the management plan for this park.

Choice of corridors (energy transport and roads):

It is, without doubt, in this area, that examples of utilization of the ecological inventories are the most numerous and especially in the case of James Bay Territory development. Therefore, we will not consider this aspect presented by Gantcheff, Normandeau and Glaude (1979) at this meeting.

Wildlife studies:

The ecological map of James Bay Territory has served as reference for studies of several animal species. Therefore, an evaluation of the potential of many species is available:

- beaver (Traversy, 1974; Levasseur and Mondoux, 1977),
- waterfowl (Bélair and Zarnovican, 1975; Mondoux et al, 1977),
- small terrestrial wildlife (Bergeron et al, 1977a, 1977b, 1977c and 1977d),
- sport fishing (Mondoux, 1976),
- moose (Jolicoeur, 1977).

This aspect is also presented in more detail by Bergeron et al (1979) during this meeting.

Hydrobiological Studies

The Water Quality Service of the Natural Resources Department has undertaken a study to establish correlations between certain criteria defining lake water quality and those parameters of the natural environment found in the ecological map (Legendre et al, 1976). The preliminary results have been very satisfactory and showed the importance of the ecological map in evaluating a certain number of hydrobiological characteristics of lakes and rivers (Paré, 1976).

Impact Analysis

The ecological map is an ideal reference in evaluating the impact of man's activities on the environment (Bailey, 1973). It helps in the evaluation of territorial capacity to integrate any development in response to the question "where, within the territory, should the proposed project be located in order to minimize the negative impact and maximize the positive impact on the environment?".

The environmental impact of the proposed Donohue pulp and paper plant at Saint-Félicien was analysed employing the resource data available from the land-system map for Saguenay/Lac-Saint-Jean (Jurdant et al, 1972b). The availbility of precise interpretated resource data for each land system provided a rapid and efficient impact evaluation (Eedy et al, 1979).

Once again, it is in reference to the James Bay hydro-electric project that this utilization has been maximized. The prime users have been the James Bay Energy Corporation and their consultants.

Experimental application of the ecological inventory and classification data has been com-

pleted by the SEER. It was carried out in reference to the creation of the Opinaca Reservoir one of the James Bay hydro-electric management projects. The territory considered covers an area of 4 000 km^2 for which we have drawn up a second ecological map according to the water level of the future reservoir. For each of the two maps (before and after flooding of the reservoir) we have done the following:

- calculation of potential, hazard and/or capability for 17 variables of the natural environment interpreted from the ecological map before and after flooding,

- a regrouping of these 17 interpretations into six groups: forest, engineering, terrestrial wildlife, aquatic wildlife and extensive recreation in nature,

- assigning a 'Socio-Economic Importance Value' to each of the five groups, according to three scenarios: one *productivist* scenario placing the accent on economic production, one *conservationist* scenario proclaming the conservation of nature and one *non-committal* scenario which gives equal importance to each group.

The 'Socio-Economic Importance Value' attributed to each resource for each scenario allowed us to define the primary and secondary uses for each land system and this, in turn, allowed us to define the 'Required Level of Integration'.

In order to obtain a global and synthetic view of the ecological diversity of land systems, we add the 'Socio-Economic Importance Value' of the five groups: from this we obtain the 'Indice du Capital Nature' before and after flooding.

The knowledge of the 'Socio-Economic Importance Value', the 'Required Level of Integration' and the 'Indice du Capital Nature' before and after flooding should allow the managers to evaluate the importance of the positive and/or negative impacts due to the creation of the Opinaca Reservoir.

Education and Awareness to the Environmental Problems

SEER studies have been used often as teaching material from the primary level (mostly in the Saguenay/Lac-Saint-Jean Region) to the university level. Courses and conferences are frequently given in the major universities in Quebec. Initiation sessions are organized at the request of users of the ecological map who come from federal and provincial departments and also at the request of teachers and students from the technical sector of colleges. Audio-visual programs describing the methodology and the results of the ecological classification are also in great demand by intermediary and civic groups.

During 1976, the University of Quebec designed an environment course for the general public in their *Télé-Université* program. The principal themes of the course were built around the principles and necessity for an ecological inventory, land management, zoning, distribution of social resources, etc. They were inspired by the studies and the methodology developed by the SEER which makes up a third of the course content.

CONCLUSIONS

The enumeration of the uses made from the results of the ecological classification and mapping in Quebec is both impressive and diversified. It gives the impression that these studies are well known.

However, except in the case of the James Bay project, this impression is false. The use of existing documents is sporadic and non-methodological. The understanding and interest in these documents rest with the personal interest of those responsible for the workshop series offered by the SEER.

It is also true that the rigouress nature of ecological maps discourages the user who thinks he will find the solution to all his problems. This attitude is due to a lack of understanding of the ecological mapping process by a large number of environmental professionals and managers working in Quebec. Once again, because of the James Bay project, this number has been greatly reduced in the last two or three years.

On the other hand, it is regrettable that no Quebec University offers a course dealing with basic ecological studies similar to those available for soil inventory.

In spite of this, a large number of Quebec ecologists are in agreement with the necessity and the urgency of forming a body which will be responsible for the ecological inventory and mapping of the province. The methodology, the scientific and the technical frameworks exist for this purpose. The only thing missing is the political willingness to make this desire a reality; this willingness will exist when the Government of Quebec totally commits itself to the management of its own resources.

REFERENCES

Bailey, R.H. 1973. Some considerations related to environmental influence assessment. Adm. Publ. Canada, pp. 370-380.

Bélair, J.L. and J.P. Ducruc. 1977. Centre agro-forestier Belle-Rivière, Mirabel. Inventaire biophysique. Service de la gestion de l'environnement. Environnement Canada, Québec, 52 p.

Bélair, J.L. and R. Zarnovican. 1975. Méthodes d'évaluation et d'interprétation du potentiel pour la sauvagine. Rapport É.T.B.J. no 27, Environnement Canada - Société de Développement de la Baie James, 23 p. Unpubl.

Bergeron, R., J.M.Levasseur and J.M.Mondoux. 1977a. Clé de potentiel pour le rat-musqué (1ère approximation). Société de Développement de la Baie James. Unpubl.

Bergeron, R., J.M.Levasseur and J.M.Mondoux. 1977b. Clé de potentiel pour le lagopède (1ère approximation). Société de Développement de la Baie James. Unpubl.

Bergeron, R., J.M.Levasseur and J.M.Mondoux. 1977c. Clé de potentiel pour la loutre (1ère approximation). Société de Développement de la Baie James. Unpubl.

Bergeron, R., J.M.Levasseur and J.M.Mondoux. 1977d. Clé de potentiel pour le lièvre (1ère approximation) Région Nottaway-Broadback-Rupert. Société de Développement de la Baie James. Unpubl.

Bergeron, R., J.M. Levasseur and J.M. Mondoux. 1979. Wildlife interpretation keys for James Bay Territory ecological classification. Proc. 2nd Meeting Can. Comm. Ecol. Land. Classif. (these proceedings). Victoria, B.C.

Carrier, L., J.L.Blouin, J.L.Brown, Z. Majcen and G. Gagnon. 1976. Description et cartographie écologique de la station forestière de Lotbinière. Service de la Recherche, Ministère des Terres et Forêts. Rapport no 175, 161 p. Unpubl.

Discuteanu, J. et al. 1974. Étude du développement du parc régional Pointe Taillon. Gauthier,Poulin,Thériault et Ass., Québec. 102 p. Unpubl.

Ducruc, J.P., L. Gerardin and D. Bérubé. 1978. Pour une utilisation optimale de la carte écologique dans le cadre d'un aménagement intégré du territoire (exemple: du réservoir Opinaca). Rapport E.T.B.J. no 37, Environnement Canada - Société de Développement de la Baie James, 18 p. Unpubl.

Eedy, W., K. Schiefer, J. Rowsell and R.McCoy. 1979. Application of biophysical land classification in the environmental assessment process: examples from various types of resources development across Canada. 2nd Meeting Canada Committee on Ecological Land Classification, 3-7 April 1978, Victoria, B.C. (incl. in these proceedings).

Filion, L. and J.L. Blouin. 1977a. Rapport d'évaluation de la proposition de réserve écologique des collines de Saint-Arnaud, Ministère des Terres et Forêts, Québec, 15 p. Unpubl.

Filion, L. and J.L. Blouin. 1977b. Rapport d'évaluation de la proposition de réserve écologique de la tourbière de Clarenceville. Ministère des Terres et Forêts, Québec, 15 p. Unpubl.

Gantcheff, G.F., P. Normandeau, and P. Glaude. 1979. The applications of the James Bay ecological inventory: a manager's appreciation. Proc. 2nd Meeting Can. Comm. Ecol. Land Classif.(these proceedings). April 3-7, 1978. Victoria, B.C. Lands Directorate. Environment Canada. Ottawa.

Jolicoeur, H. 1977. Clé d'évaluation du potentiel du Territoire de la Baie James pour l'orignal (1ère approximation). Direction Générale de la Faune, Ministère du Tourisme, de la Chasse et de la Pêche, Québec,R.R.F-2, 56 p. Unpubl.

Jurdant, M. 1964. Carte phytosociologique et forestière de la forêt expérimentale de Montmorency. Direction des Recherches Forestières, Ministère des Forêts, Canada, No 1046F, 73 p.

Jurdant, M., J.L. Bélair and V. Gerardin. 1972a. Carte écologique du Mont Valin (types écologiques). Service des Études Écologiques Régionales, Environnement Canada, Québec. Unpubl. map.

Jurdant, M., J. Beaubien, J.L. Bélair, J.C. Dionne and V. Gerardin. 1972b. Carte écologique de la région du Saguenay-Lac-Saint-Jean: notice explicative. Centre de Recherches Forestières des Laurentides, Environnement Canada, Québec. Rapport d'information Q-F-X-31, 93 p.

Jurdant, M., J.L. Bélair and V. Gerardin. 1976a. Concepts méthodologiques pour la classification et l'inventaire écologique du territoire québécois. Conseil de la Recher-

che et du Développement Forestier, Ministère des Terres et Forêts, Québec. Rapport no 5, 79 p.

Jurdant, M., J.L. Bélair, V. Gerardin and J.P. Ducruc. 1977. L'inventaire du Capital-Nature. Methode de classification et de cartographie écologiques du territoire (3ème approximation). Ecological Land Classification Series no 2. Lands Directorate, Environment Canada, Québec. 202 p.

Jurdant, M. and G. Frisque. 1970. The Nicauba Research Forest. A research area for black spruce in Quebec. Part 1: forest land survey. Service forestier du Canada, Ministère de l'environnement. Rapport d'information Q-X-18, 115 p.

Jurdant, M. and V. Gerardin. 1977. La classification écologique du territoire au Québec: un outil pour la gestion de l'environnement. *in* Proc. Sym. on Ecol. Classification of forest land in Canada and Northwestern U.S.A. Sept. 30 - Oct. 2, 1977, Vancouver, B.C.: pp. 245-263.

Legendre, P., C. Paré and F. Land. 1976. Classification des lacs: physico-chimie, phytoplancton et photo-interprétation. Comptes rendus du Symposium. Environnement - Baie James, Montréal, 19-20 mai 1976: 376-387.

Levasseur, J.M. and J.M. Mondoux. 1977. Clé de potentiel pour le castor (3ème approximation). Rapport E.T.B.J. no 35, Environnement Canada - Société de Développement de la Baie James. 3 p. Unpubl.

Majcen, Z. and G. Gagnon. 1976. Description écologique et cartographie des groupements forestiers de la station forestière de la Baie des Chaleurs. Service de la Recherche, Ministère des Terres et Forêts, Québec. Rapport no 121, 114 p. Unpubl.

Mondoux, J.M. 1976. Evaluation du potentiel pour le brochet du nord, le doré jaune, la truite mouchetée, la truite grise et la ouananiche (1ère approximation). Rapport E.T.B.J. no 29, Environnement Canada - Société de développement de la Baie James, 37 p. Unpubl.

Mondoux, J.M., J.M. Levasseur and D. Lehoux. 1977. Evaluation du potentiel pour la sauvagine (3ème approximation). Rapport E.T.B.J. no 34, Environnement Canada - Société de développement de la Baie James, 4 p. Unpubl.

Paré, C. 1976. Classification des lacs de Radissonnie. L'hypothèse de base et exacte... Ministère des Richesses Naturelles, Québec, 14 p. Unpubl.

Pouliot, J. and L. Provencher. 1977. Etude des caractéristiques biophysiques du parc du Mont-Orford. Ministère du Tourisme, de la Chasse et de la Pêche, Québec, 112 p. Unpubl.

Traversy, N. 1974. Méthode expérimentale de classement potentiel de l'habitat pour le castor de la Baie James (2ième approximation) Service de la Recherche biologique, Ministère du Tourisme, de la Chasse et de la Pêche, 24 p. Unpubl.

ABSTRACT

The current status of ecological land inventory and classification in Quebec in areas other than the James Bay Territory is outlined. Practical applications of ELC information for land zoning, forest management, management area selection, hydrobiological studies, impact analysis and promotion of environmental awareness are examined. The process of ecological land classification now appears to be generally understood by the majority of environmental professionals and managers in Quebec but, as yet, few politicians. Hence, the goal of a comprehensive ecological mapping of Quebec's resources remains unattained. (Ed. Abstr.)

RÉSUMÉ

L'Auteur présente l'état actuel de la classification et de l'inventaire écologique des terres au Québec dans les régions autres que celles de la baie James. Il examine les applications pratiques tirées des renseignements sur la classification écologique des terres pour le zonage des terres, l'aménagement forestier, le choix des régions à aménager, les études hydrobiologiques, l'analyse des incidences et la stimulation de l'intérêt pour l'environnement. Il semble que, au Québec, la méthode de classification écologique des terres est désormais une chose comprise en général par la majorité des professionnels et des gestionnaires de l'environnement, mais seulement par quelques hommes politiques. La cartographie écologique exhaustive des ressources du Québec demeure par conséquent inachevée. (Rés. Éd.)

PRINCIPALES UTILISATIONS DE L'INVENTAIRE ET DE LA CLASSIFICATION ÉCOLOGIQUES DU TERRITOIRE AU QUÉBEC*

J. P. Ducruc
Service des Études Écologiques Régionales
Environnement Canada
Québec, Québec

INTRODUCTION

Ce texte reprend, dans ses grandes lignes, le texte présenté par Jurdant et Gerardin (1977) au symposium sur la classification des terrains forestiers au Canada et dans le nord-ouest des Etats-Unis tenu à Vancouver, en octobre 1977. Cependant, nous ne présenterons ici que les applications de l'inventaire et de la classification écologiques du territoire déjà réalisées au Québec. Nous passerons sous silence celles, pourtant nombreuses, encore souhaitables et facilement réalisables du point de vue méthodologique. Nous ne nous attarderons pas non plus sur les applications (certainement les plus nombreuses et les plus complètes) actuellement en cours à la Société de Développement de la Baie James et à la Société d'Energie de la Baie James dans le cadre du projet hydro-électrique de la Baie James, puisqu'elles feront l'objet de présentation dans le cadre même de cette réunion.

INVENTAIRE ET CLASSIFICATION ÉCOLOGIQUES DU TERRITOIRE AU QUÉBEC

Bref Historique

Avant l'avènement des études de base qui ont précédé la préparation des cartes de l'Inventaire des Terres du Canada (I.T.C.), les inventaires écologiques au Québec étaient centrés sur les sols, en agriculture et sur la végétation, en foresterie.

L'élaboration des cartes de l'I.T.C. provoqua une demande d'information de base plus systématique et une réflexion plus profonde sur la nécessité, pour le Québec, de se doter d'une méthode uniforme d'inventaire et de classification écologiques du territoire. Le Conseil de la Recherche et du Développement Forestier créa, en 1972, le Comité d'Ecologie Appliquée à l'Aménagement du Territoire qui, à son tour, forma un Sous-Comité de la Classification Ecologique du Territoire. C'était, en fait, un groupe technique regroupant la plus grande partie des spécialistes oeuvrant dans ce domaine au Québec; il avait comme principal objectif de formuler des recommandations visant à promouvoir une méthodologie d'inventaire et de classification écologiques du territoire uniforme pour le Québec. En 1975, le Sous-Comité présenta son rapport sur les concepts méthodologiques pour la classification et l'inventaire écologiques du territoire, publié l'année suivante par le Conseil de la Recherche et du Développement Forestier (Jurdant et al, 1976a).

Le rapport recommandait, au gouvernement du Québec, d'entreprendre l'inventaire et la classification écologiques systématiques de l'ensemble du territoire. A raison de 75 000 km^2 par an, la durée totale du programme était prévue pour 20 ans avec des dépenses annuelles, en dollars 1975, de $1 million. Ce programme serait réalisé sous l'égide d'un organisme central regroupant toutes les compétences (ministères provinciaux, fédéraux et universités) oeuvrant dans le domaine. Cet organisme, pour lequel le nom d'Institut de la Carte Ecologique était proposé, aurait opéré sous la juridiction de l'organisme central de planification du Québec qui existe déjà: l'Office de Planification et de Développement du Québec" (O.P.D.Q.).

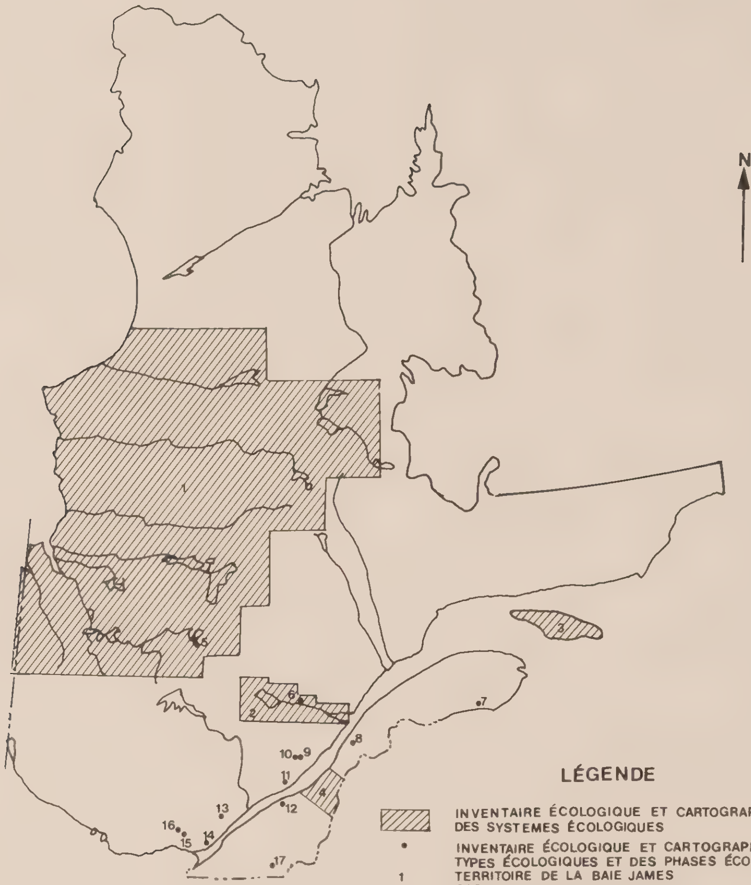
Malheureusement, en mars 1978, il n'existe toujours pas, au Québec, d'organisme central, ni pour réaliser, ni pour coordonner un quelconque programme d'inventaire et de classification écologiques. Les inventaires se font toujours sur une base ad hoc sauf au Ministère des Terres et Forêts et à Environnement Canada dont les travaux se conforment aux concepts méthodologiques énoncés par le Comité d'Ecologie Appliquée à l'Aménagement du Territoire.

État Des Inventaire (Mars 1978)

Evidemment, nous référons ici aux seuls inventaires qui se réclament, à notre connaissance, des *Concepts méthodologiques pour la classification et l'inventaire écologiques du territoire québécois* (Jurdant et al, 1976a).

*Résumé/Abstract à/on page 208.

FIG 1. ÉTAT DES INVENTAIRES ÉCOLOGIQUES AU QUÉBEC (tiré de Jurdant et Gerardin, 1977)



LÉGENDE

- (hachuré) INVENTAIRE ÉCOLOGIQUE ET CARTOGRAPHIE DES SYSTEMES ÉCOLOGIQUES
- • INVENTAIRE ÉCOLOGIQUE ET CARTOGRAPHIE DES TYPES ÉCOLOGIQUES ET DES PHASES ÉCOLOGIQUES

1 TERRITOIRE DE LA BAIE JAMES
2 SAGUENAY-LAC-SAINT-JEAN
3 ILE D'ANTICOSTI
4 FORÊT DOMANIALE DES APPALACHES
5 FORÊT DE NICAUBA
6 MONT-VALIN
7 STATION FORESTIÈRE DE LA BAIE DES CHALEURS
8 STATION FORESTIÈRE DE PARKE
9 FORÊT MONTMORENCY
10 RIVIÈRE MONTMORENCY
11 STATION FORESTIÈRE DE DUCHESNAY
12 STATION FORESTIÈRE DE LOTBINIÈRE
13 SAINT-ALEXIS
14 BELLE-RIVIÈRE
15 STATION FORESTIÈRE D'ARGENTEUIL
16 MONT-TREMBLANT
17 MONT-ORFORD

ÉCHELLE 1:12 000 000

Ministère des Terres et Forêts:

Le Service de la Recherche de ce ministère a entrepris un programme d'inventaire écologique à grande échelle des diverses stations de recherches forestières au niveau de la *Phase Ecologique* et/ou du *Type Écologique* (Carrier et al, 1976; Majcen et Gagnon, 1976).

Ce service a également en cours un programme de cartographie des *Systèmes Écologiques* à l'échelle de 1:125 000 dans la région des Appalaches et un programme de définition des *Régions Écologiques* pour l'ensemble du Québec méridional.

Le Service de l'Aménagement des Terres a aussi entrepris l'inventaire écologique détaillé des réserves écologiques au niveau de la *Phase Ecologique* et/ou du *Type Écologique* (Filion et Blouin, 1977a, 1977b) suivant Figure 1.

Ministère du Tourisme, de la Chasse et de la Pêche:

La Direction des Parcs a entrepris la réalisation d'une carte écologique intégrée du parc du Mont-Orford et la description de son potentiel biophysique en fonction d'aménagement éventuel, d'activités récréatives de plein-air et d'une ébauche d'un programme d'interprétation de la nature (Pouliot et Provencher, 1977). Le parc sera cartographié au 1:10 000 au niveau du *Type Ecologique*.

Environnement Canada:

Le Service des Études Écologiques Régionales (SEER) a, pour sa part, réalisé des inventaires écologiques à diverses échelles:

- carte des *Phases Écologiques* au 1:8 000 de la forêt expérimentale de Nicauba (Jurdant et Frisque, 1970),
- carte des *Types Écologiques* au 1:4 000 de la forêt expérimentale de Montmorency (Jurdant, 1964),
- carte des *Types Écologiques* au 1:15 000 du Mont Valin (Jurdant et al, 1972a),
- carte des *Systèmes Écologiques* au 1:125 000 de la région du Saguenay Lac St-Jean et de la Baie James (Jurdant et al, 1972b; 1976b).

UTILISATION DES INVENTAIRES ET CLASSIFICATION ÉCOLOGIQUES

Le Zonage

Grâce aux interprétations concernant la production potentielle des ressources naturelles renouvelables, les aménagistes, en collaboration avec les écologistes peuvent recommander une affectation particulière à chaque unité issue de la classification écologique. Il est alors possible de produire un plan de zonage intégré du territoire. Malgré l'urgence d'un tel zonage et malgré les nombreuses promesses électorales, le Québec ne s'est toujours pas doté d'une politique globale de zonage intégré. Cependant, on peut mentionner quelques expériences très locales d'un tel zonage.

La municipalité de St-Fulgence, dans la région du Saguenay, en collaboration avec le Ministère des Affaires Municipales du Québec, a établi un plan de zonage intégré basé sur la cartographie des systèmes écologiques et la classification des types écologiques d'après les travaux de Jurdant et al (1972b). Les paramètres utilisés furent les risques d'érosion, le potentiel pour l'ingénierie, la topographie, le potentiel récréatif des systèmes aquatiques et l'attrait des paysages.

Le Service de l'Aménagement des Terres, du Ministère des Terres et Forêts du Québec s'est vu confié, en 1974, l'établissement d'un plan d'aménagement de l'Ile d'Anticosti. Les données de base de l'inventaire écologique furent stockées dans une banque de données à partir de laquelle toute une série de cartes interprétatives furent automatiquement produites. La compilation et l'analyse de ces résultats ont permis de définir les prescriptions d'aménagement de l'Ile.

Actuellement, la Société de Développement de la Baie James est responsable du projet d'aménagement du territoire le plus important au Québec. Il est en cours d'élaboration et la Société s'est donnée tous les moyens pour utiliser au maximum les données de base de l'inventaire et de la classification écologiques. La communication de Gantcheff, Normandeau et Glaude (1979) et de Bergeron et al (1979) a cette réunion le montrent clairement.

La Gestion Des Forêts

La planification des travaux de reboisement:

Dans la région du Saguenay Lac St-Jean, le Ministère des Terres et Forêts planifie ses opérations de reboisement en utilisant les données de l'inventaire écologique. Dans le choix, des aires et des espèces à reboiser, les forestiers tiennent compte d'une série de facteurs interprétables à partir de la carte écologique, surtout en ce qui concerne le choix des espèces par rapport aux caractéristiques pédologiques des stations à reboiser:

- la vocation des sols pour diverses espèces ligneuses,

- les difficultés de plantation,

- le potentiel de régénération naturelle,

- les espèces agressives après coupe à blanc ou feu,

- la traficabilité,

- les niveaux de complémentarité et/ou de compatibilité avec d'autres ressources naturelles (agriculture, attrait du paysage, etc.).

Le choix des pratiques sylvicoles:

La cartographie des types écologiques d'un canton de la région du Lac St-Jean a permis aux forestiers du Service de la Restauration du Ministère des Terres et Forêts de définir les sites dans lesquels il était préférable, pour cause de rentabilité, d'effectuer des coupes pré-commerciales, des coupes de régénération et/ou des coupes commerciales.

De plus, la connaissance des essences les plus productives selon le type écologique leur a permis de recommander l'utilisation de pratiques sylvicoles favorisant la régénération de ces espèces.

Actuellement, le Service des Plans d'Aménagement du Ministère des Terres et Forêts utilise la carte écologique du Territoire de la Baie James pour établir le profil biophysique des Unités de Gestion de Matagami et de Chibougamau. L'unité de gestion est une unité administrative subdivisée en portions territoriales selon des limites physiques (cours d'eau, route) et/ou des limites de peuplement. Les forestiers ont superposé ces limites sur la carte des systèmes écologiques; ils ont alors réévalué la répartition des types écologiques dans leurs unités à partir des systèmes écologiques cartographiés. Malgré les difficultés inhérentes à ce genre de superposition, ils ont pu évaluer très rapidement certaines caractéristiques écologiques de leurs cellules: nature des dépôts géomorphologiques, classes de drainage et potentiel forestier. A partir de ces données, ils préconisent l'utilisation des pratiques sylvicoles les plus appropriées, ils évaluent les coûts d'exploitation et ils déterminent les superficies à reboiser.

Choix Des Aires Propices À Un Aménagement Intensif

Agricole:

Le Ministère de l'Agriculture du Québec, en collaboration avec le Service des Études Écologiques Régionales, a défini le type de culture le mieux adapté à chaque type écologique, dans la région du Saguenay Lac St-Jean.

Recréatif:

L'étude de développement du parc régional Pointe-Taillon (Discuteanu et al, 1974), commandée par le Service des Parcs du Ministère du Tourisme, de la Chasse et de la Pêche est presqu'exclusivement basée sur l'analyse des systèmes écologiques de la carte écologique du Saguenay Lac St-Jean. Seules, une analyse subjective des paysages et une carte de la végétation actuelle furent ajoutées aux données de base pour établir le plan d'aménagement du secteur.

Choix de corridors (transport d'énergie et routes):

C'est sans doute dans ce domaine que les exemples d'utilisation des inventaires écologiques sont les plus utilisés, particulièrement dans le cadre du développement du Territoire de la Baie James. Nous ne développons cependant pas ici cet aspect présenté par Gantcheff et al (1979) dans le cadre même de cette réunion.

Étude de la faune:

La carte écologique du territoire de la Baie James a servi de cadre de référence à l'étude de plusieurs espèces animales. Ainsi, l'évaluation du potentiel pour plusieurs espèces a vu le jour:

- le castor (Traversy, 1974; Levasseur et Mondoux, 1977),

- la sauvagine (Bélair et Zarnovican, 1975; Mondoux et al, 1977),

- la petite faune terrestre (Bergeron et al, 1977a, 1977b, 1977c et 1977d),

- les poissons sportifs (Mondoux, 1976),

- l'orignal (Jolicoeur, 1977).

Cet aspect là est, lui aussi, repris beaucoup

plus en détail par Bergeron et al , (1978) dans le cadre même de ce symposium.

Études Hydro-biologiques

Le Service de la Qualité des Eaux du Ministère des Richesses Naturelles a entrepris une étude visant à établir des corrélations entre certains paramètres du milieu naturel contenus dans la carte écologique (Legendre et al. 1976).

Les résultats préliminaires sont très probants et permettent d'envisager une bonne utilisation de la carte écologique pour évaluer un certain nombre de caractéristiques hydro-biologiques des lacs et des rivières (Paré, 1976).

Analyse D'impacts

La carte écologique intégrée est un cadre de référence idéal dans le processus d'évaluation des impacts des activités de l'homme sur l'environnement (Bailey, 1973). Elle permet d'évaluer, de façon globale, la capacité du territoire à digérer un certain développement et de répondre à la question: "où, dans le territoire, le projet proposé doit-il être réalisé afin de minimiser l'impact négatif et maximiser l'impact positif sur l'environnement?"

Les résultats de l'inventaire et de la cartographie écologique du Saguenay Lac St-Jean (Jurdant et al, 1972b) ont été avantageusement utilisés lors d'une analyse d'impact concernant l'implantation de l'usine de pâtes et papiers de la compagnie Donohue à Saint-Félicien (Eedy et al, 1979). Dans ce cas, ce sont surtout les valeurs interprétatives attribuées à chaque système écologique qui ont permis de procéder "rapidement et efficacement à une évaluation d'impact sur le milieu terrestre" (Eedy et al , 1979, pp.2).

Cependant, encore une fois, c'est dans le cadre du projet général d'aménagement hydro-électrique de la Baie James que cette utilisation a été maximale. Le principal utilisateur étant la Société d'Energie de la Baie James et/ou ses contractants. Encore une fois, cet aspect sera aussi traité plus en détail par Gantcheff, Normandeau et Glaude (1979) dans le cadre même de cette réunion.

Un essai d'application originale des données de l'inventaire et de la classification écologiques est en voie d'achèvement au SEER (Ducruc et al, 1978). Il a été effectué dans le cadre de la création du réservoir Opinaca, un des éléments de l'aménagement hydro-électrique de la Baie James. Le territoire considéré couvre une superficie de 4000 km^2 pour lesquels nous avons effectué une deuxième cartographie écologique suivant le niveau d'eau du futur réservoir. Ensuite, pour chacune des deux cartographies (avant et après création du réservoir), nous avons effectué les opérations suivantes:

- calcul de potentiels, risques et/ou aptitudes pour 17 variables du milieu naturel, interprétables à partir de la carte écologique avant et après inondation,
- regroupement de ces 17 interprétations en cinq secteurs: forêt, ingénierie, faune terrestre, faune aquatique et récréation extensive dans la nature,
- attribution d'une *Valeur d'Importance Socio-Economique* (VISE) (Jurdant et al, 1977) à chacun des cinq secteurs selon trois scénarios: un scénario *productiviste* mettant l'accent sur la production économique; un scénario *conservationiste* privilégiant la conservation de la nature; un scénario *non-engagé* donnant autant d'importance à chaque secteur.

Les VISE attribuées à chaque ressource pour chacun des scénarios retenus permettent de définir les utilisations principales et les utilisations secondaires pour chaque système écologique et, de là, le *Niveau d'Intégration Requis*.

Ensuite, pour obtenir une image synthétique et globale de la diversité écologique des systèmes écologiques, on additionne les VISE des cinq secteurs; on obtient alors un *Indice du Capital-Nature*, avant et après inondation.

La connaissance avant et après inondation des VISE, des niveaux d'intégration requis et de l'indice du capital-nature devrait permettre, aux aménagistes, d'évaluer l'importance des impacts positifs et/ou négatifs dus à la création du réservoir Opinaca.

Éducation Et Sensibilisation Aux Problèmes De L'environnement

Les travaux du SEER ont abondamment servi de matériel pédagogique du niveau primaire (principalement dans la région du Saguenay Lac St-Jean) jusqu'au niveau universitaire.

Cours et conférences sont fréquemment présentés dans les principales universités du Québec. Des stages d'initiation sont organisés à la demande d'utilisateurs de la carte écologique venant d'autres ministères du gouvernement canadien et de ministères provinciaux (Tourisme, Chasse et Pêche, Richesses Naturelles, Terres

et Forêts, Agriculture), à la demande aussi d'enseignants et d'étudiants du secteur technique des CEGEP. Des montages audio-visuels vulgarisant la méthodologie et les résultats de la classification écologique du territoire, sont aussi très en demande auprès de nombreux corps intermédiaires et des groupes de pression populaire.

Au cours de l'année 1976, l'Université du Québec a conçu un cours populaire sur l'environnement par le truchement de son programme *Télé-Université*. Les thèmes principaux de ce cours reprennaient les principes et la nécessité d'un inventaire écologique du territoire, de l'aménagement du territoire, du zonage du territoire, de la redistribution des richesses sociales, etc. Pour ce faire, il s'inspirait très fortement des travaux et de la méthodologie développée au SEER, d'autant plus que SEER eut à concevoir un tiers du cours.

CONCLUSION

L'énumération des utilisations faites des résultats de la classification et de la cartographie écologiques au Québec est assez impressionnante et assez bien diversifiée. Elle donne l'impression que ces travaux sont d'intérêt reconnu. Mais, hormis dans le cas, cependant non négligeable, du projet de la Baie James, cette impression est trompeuse. Les utilisations des documents existants sont sporadiques et non méthodiques. Leur compréhension et leur intérêt reposent avant tout sur l'intérêt personnel des responsables ou sur les stages d'initiation offerts par le SEER.

Il est vrai aussi que la carte écologique rebute, par son austérité, plus d'un utilisateur qui pensait trouver en elle solution à tous ses problèmes; ceci est dû à la méconnaissance quasi-totale du contenu de la carte écologique et de la méthodologie de son établissement par une grande partie des professionnels de l'environnement et de l'aménagement oeuvrant au Québec. Cependant, encore une fois, grâce au projet de la Baie James, ce nombre a fortement diminué au cours des deux ou trois dernières années. Par contre, il est toujours aussi regrettable de constater qu'aucune université québécoise n'offre de cours portant sur les inventaires écologiques de base comme il en existe, par exemple, pour les inventaires pédologiques.

Malgré cela, une forte majorité d'écologistes québécois s'accorde pour reconnaître la nécessité et l'urgence de fonder un organisme responsable de l'inventaire et de la cartographie écologiques du territoire. La méthodologie, l'encadrement technique et scientifique existent pour les réaliser. Seule, manque la volonté politique pour traduire ces voeux en réalité; elle se concrétisera lorsque le Québec s'engagera à fond dans un véritable aménagement intégré de ses ressources.

RÉFÉRENCES

Bailey, R.H. 1973. Some considerations related to environmental influence assessment. Adm. Publ. Canada., pp. 370-380.

Bélair, J.L. et J.P. Ducruc. 1977. Centre agro-forestier Belle-Rivière, Mirabel. Inventaire biophysique. Service de la gestion de l'environnement. Environnement Canada, Québec, 52 p.

Bélair, J.L. et R. Zarnovican. 1975. Méthodes d'évaluation et d'interprétation du potentiel pour la sauvagine. Rapport E.T.B.J. Nº 27, Environnement Canada - Société de Développement de la Baie James, 23 p. Non publié.

Bergeron, R., J.M. Levasseur et J.M. Mondoux. 1977a. Clé de potentiel pour le rat-musqué (1ère approximation). Société de Développement de la Baie James. Non publié.

Bergeron, R., J.M. Levasseur et J.M. Mondoux. 1977b. Clé de potentiel pour le lagopède (1ère approximation). Société de Développement de la Baie James. Non publié.

Bergeron, R., J.M. Levasseur et J.M. Mondoux. 1977c. Clé de potentiel pour la loutre (1ère approximation). Société de Développement de la Baie James. Non publié.

Bergeron, R., J.M. Levasseur et J.M. Mondoux. 1977d. Clé de potentiel pour le lièvre (1ère approximation) Région Nottaway-Broadback-Rupert. Société de Développement de la Baie James. Non publié.

Bergeron, R., J.M. Levasseur et J.M. Mondoux. 1979. Wildlife interpretation keys for James Bay Territory ecological classification. *dans* Compte rendu 2ième réunion Com. Can. Classif. Écol. Terr. pp. 145-152. Dir. gén. terres. Ottawa. (inclus dans ce volume).

Carrier, L., J.L. Blouin, J.L. Brown, Z. Majcen et G. Gagnon. 1976. Description et cartographie écologique de la station forestière de Lotbinière. Service de la Recherche, Ministère des Terres et Forêts. Rapport Nº 175, 161 p. Non publié.

Discuteanu, A. et al. 1974. Étude du développement du parc régional Pointe Taillon. Gauthier,Poulin,Thériault et Ass., Québec, 102 p. Non publié.

Ducruc, J.P., L. Gerardin et D. Bérubé. 1978. Pour une utilisation optimale de la carte écologique dans le cadre d'un aménagement intégré du territoire. (exemple: du réservoir Opinaca). Rapport E.T.B.J. N° 37, Environnement Canada - Société de Développement de la Baie James, 18 p. Non publié.

Eedy, W., K. Schiefer, J. Rowsell et R. McCoy. 1979. Application of biophysical land classification in the environmental assessment process: examples from various types of resource development across Canada. *dans* Compte rendu 2ième réunion Com. Can. Classif. Écol. Terr. (compilé et édité par C.D. Rubec). Dir. gén. terres. Ottawa. (inclus dans ce volume).

Filion, L. et J.L. Blouin. 1977a. Rapport d'évaluation de la proposition de réserve écologique des collines de Saint-Arnaud, Ministère des Terres et Forêts, Québec, 15 p. Non publié.

Filion, L. et J.L. Blouin. 1977b. Rapport d'évaluation de la proposition de réserve écologique de la tourbière de Clarenceville. Ministère des Terres et Forêts, Québec. 15 p. Non publié.

Gantcheff, G.F., P. Normandeau, et P. Glaude. 1979. Les applications de l'inventaire écologique de la Baie James: Une appréciation de gestionnaire. Compte rendu de la 2ième réunion, la Comité canadien de la classification écologique du territoire. Série CÉT numéro 7. Environnement Canada. Ottawa.

Jolicoeur, H. 1977. Clé d'évaluation du potentiel du Territoire de la Baie James pour l'orignal (1ère approximation). Direction Générale de la Faune, Ministère du Tourisme, de la Chasse et de la Pêche, Québec, R.R.F.-2, 56 p. Non publié.

Jurdant, M. 1964. Carte phytosociologique et forestière de la forêt expérimentale de Montmorency. Direction des Recherches Forestières. Ministère des Forêts, Canada. N° 1046F, 73 p.

Jurdant, M., J.L. Bélair et V. Gerardin. 1972a. Carte écologique du Mont Valin (types écologiques). Service des Études Ecologiques Régionales, Environnement Canada, Québec. Carte non publiée.

Jurdant, M., J. Beaubien, J.L. Bélair, J.C. Dionne et V. Gerardin. 1972b. Carte écologique de la région du Saguenay/Lac-Saint-Jean: notice explicative. Centre de Recherches Forestières des Laurentides, Environnement Canada, Québec. Rapport d'information Q-F-X-31, 93 p.

Jurdant, M., J.L. Bélair et V. Gerardin. 1976a. Concepts méthodologiques pour la classification et l'inventaire écologiques du territoire québécois. Conseil de la Recherche et du Développement Forestier, Ministère des Terres et Forêts, Québec. Rapport N° 5. 79 p.

Jurdant, M., J.L. Bélair, J.P. Ducruc et V. Gerardin. 1976b. La carte écologique intégrée du Territoire de la Baie James. *dans* Série de la classification écologique du territoire, no 1, Direction générale des terres, Environnement Canada. pp. 173-199.

Jurdant, M., J.L. Bélair, V. Gerardin et J.P. Ducruc. 1977. L'inventaire du Capital-Nature. Méthode de classification écologique du territoire, N° 2, Direction générale des terres, Environnement Canada, Québec. 202 p.

Jurdant, M. et G. Frisque. 1970. The Nicauba Research Forest. A research area for black spruce in Quebec. Part 1: forest land survey. Service forestier du Canada, Ministère de l'environnement. Rapport d'information Q-X-18, 115 p.

Jurdant, M. et V. Gerardin. 1977. La classification écologique du territoire au Québec: un outil pour la gestion de l'environnement. Proceedings of Ecological Classification of forest land in Canada and Northwestern U.S.A. Sept. 30 - Oct. 2, 1977, Vancouver, B.C.. pp. 245-263.

Legendre, P., C. Paré et F. Lang. 1976. Classification des lacs: physico-chimie, phytoplancton et photo-interprétation. Compte rendu du Symposium, Environnement Baie James - Montréal, 19-20 mai 1976. pp. 369-387.

Levasseur, J.M. et J.M. Mondoux. 1977. Clé de potentiel pour le castor (3ième approximation). Rapport E.T.B.J. N° 35, Environnement Canada - Société de Développement de la Baie James. 3 p. Non publié.

Majcen, Z. et G. Gagnon. 1976. Description écologique et cartographie des groupements forestiers de la station forestière de la Baie des Chaleurs. Service de la Recherche. Ministère des Terres et Forêts, Québec. Rapport N° 121, 114 p. Non publié.

Mondoux, J.M. 1976. Evaluation du potentiel pour le brochet du nord, le doré jaune, la truite mouchetée, la truite grise et la ouananiche (1ère approximation) Rapport É.T.B.J. N° 29, Environnement Canada - Société de

Développement de la Baie James, 37 p. Non publié.

Mondoux, J.M., J.M. Levasseur et D. Lehoux. 1977. Evaluation du potentiel pour la sauvagine (3ième approximation). Rapport E.T.B.J. N° 34, Environnement Canada - Société de Développement de la Baie James, 4 p. Non publié.

Paré, C. 1976. Classification des lacs de Radissonnie. L'hypothèse de base et exacte... Ministère des Richesses Naturelles, Québec, 14 p. Non publié.

Pouliot, J. et L. Provencher. 1977. Etude des caractéristiques biophysiques du parc du Mont-Orford. Ministère du Tourisme, de la Chasse et de la Pêche, Québec, 112 p. Non publié.

Traversy, N. 1974. Méthode expérimentale de classement potentiel de l'habitat pour le castor de la Baie James (2ième approximation) Service de la Recherche biologique, Ministère du Tourisme, de la Chasse et de la Pêche, 24 p. Non publié.

RÉSUMÉ

L'auteur présente l'état actuel de la classification et de l'inventaire écologique des terres au Québec dans les régions autres que celles de la baie James. Il examine les applications pratiques tirées des renseignements sur la classification écologique des terres pour le zonage des terres, l'aménagement forestier, le choix des régions à aménager, les études hydrobiologiques, l'analyse des incidences et la stimulation de l'intérêt pour l'environnement. Il semble que, au Québec, la méthode de classification écologique des terres est désormais une chose comprise en général par la majorité des professionnels et des gestionnaires de l'environnement, mais seulement par quelques hommes politiques. La cartographie écologique exhaustive des ressources du Québec demeure par conséquent inachevée. (Rés. Éd.)

ABSTRACT

The current status of ecological land inventory and classification in Quebec in areas other than the James Bay Territory is outlined. Practical applications of ELC information for land zoning, forest management, management area selection, hydrobiological studies, impact analysis and promotion of environmental awareness are examined. The process of ecological land classification now appears to be generally understood by the majority of environmental professionals and managers in Quebec but, as yet, few politicians. Hence, the goal of a comprehensive ecological mapping of Quebec's resources remains unattained. (Ed. Abstr.)

PARKS CANADA APPLICATION OF BIOPHYSICAL LAND CLASSIFICATION FOR RESOURCES MANAGEMENT

K. M. East
D. L. Day
Natural Resources Div.
National Parks Branch
Ottawa, Ontario

D. Le Sauteur
Resource Conservation Div.
Atlantic Regional Office
Parks Canada
Halifax, Nova Scotia

W. M. Stephenson
L. Charron
Resource Conservation Div.
Parks Canada
Cornwall, Ontario

ABSTRACT

Biophysical Land Classification is a theoretical model applied by Parks Canada to the organization and collection of its Parks' natural resource data. Its application is closely tied to evolving concepts of resource management and master planning and reflects the need of a variety of users for specific types of information.

Through reference to Parks Canada's land management mandate, the evolution and application of a functional approach to BPLC is developed. The status of current and past mapping programs is documented, and a profile of user groups and of the range of their information requirements is presented.

RÉSUMÉ

La classification biophysique du territoire est un modèle théorique utilisé par Parcs Canada pour la mise sur pied et l'éxécution des programmes d'inventaire des ressources naturelles des Parcs nationaux. Son application est liée à l'évolution des concepts de gestion des ressources naturelles ainsi qu'à celle de la définition du plan directeur. Elle reflète une variété de besoins spécifiques exprimés par les différents utilisateurs.

Dans l'optique du mandat de gestion des ressources de Parcs Canada, on nous expose les diverses étapes de la mise au point d'une méthode fonctionnelle de classification biophysique du territoire. Le statut des diverses approches cartographiques utilisées jusqu'à présent y est aussi étudié. De plus, on nous présente un profil type de l'utilisateur ainsi que de l'information requise.

INTRODUCTION

"The National Parks of Canada," according to the National Parks Act, "are hereby dedicated to the people of Canada for their benefit, education and enjoyment...and shall be maintained and made use of so as to leave them unimpaired for the enjoyment of future generations." Since 1887, variations on this mandate have served as the fundamental purpose of the National Park system with interpretations of the day being derived from changing social attitudes and revised government priorities.

By the late 1960's, substantial pressure was being exerted on the National Parks Branch to adopt a stronger 'preservationist' or 'protectionist' stance in its management of the parks. Proponents of this position reasoned that the terms 'preserve' and 'unimpaired' inferred that the parks be managed in a more conservative manner with severe restrictions being placed on certain kinds of uses or development. These same interests, using Provisional Master Plan public hearings as their platform, further contended that management to date had been based on inadequate knowledge of park natural resources and the probable effects of proposed management action.

The Branch response was to establish the Resource Inventory Task Force which, in its first report in December 1971, agreed in large part with the observations made during the public hearings.

> "Today's accelerated tempo places more pressure upon the National Parks System. Increased visitor use and new recreational activities have created demands for new and expanded services, and have also lengthened the season of active use. Consequently, development proposals are growing larger in scope. Logical, defensible decisions must be made to keep pace with this accelerated tempo. Careful decisions which consider the values involved, rather than the expediencies of the moment, require factual data concerning all the various aspects of the matter under consideration. These data must readily be available in a form that will facilitate such decisions. When a decision concerning natural values and resources of the National Parks must be made, the information now at hand is seldom adequate. Reliable quantitative

and qualitative information concerning the natural resources is rarely available and almost never assembled for ready reference. What is available must be laboriously assembled from a bewildering variety of unstandardized source data. It is obvious that this procedure cannot meet today's accelerated pace."

Natural Resources Studies Program

Subsequent recommendations by the Task Force led to establishment of a detailed natural resource inventory program which evolved, together with other special topic studies, into the Natural Resource Studies Program (NRSP). The objectives of NRSP are as follows:

a) identify and assemble a natural resource data base dealing with the quantitative and qualitative aspects of the natural resource components;

b) describe the ecological interactions among natural resource components to facilitate understanding of how ecosystems function and the processes which contribute to their natural development;

c) locate and identify representative, special and unique natural resource components;

d) perform comprehensive natural resources monitoring, including the establishment of bench-marks and indicators, to update information and identify environmental changes resulting naturally or from induced impacts on the resource base;

e) identify components or locations where detailed natural resource information or possible management action will be required;

f) provide suitable information and information treatments to assure the most appropriate utilization of the natural resource components consistent with the environmental potential;

g) provide a vehicle for making the information available to all the prospective users;

h) provide a sound technical basis for evaluating research and management programs directed towards these ends.

NRSP has two components: inventory studies which are directed toward the development of a base-line description of a park's natural resources, and management studies directed toward the solution of specified management concerns. The relationship of the former to general information requirements will be predictive while that of the latter will be reactive. A suitable level of anticipation during the inventory will reduce ongoing demands for management studies. The following paper is largely concerned with the inventory component of NRSP.

Inventory Design

In an overview sense, four major factors appear to dictate the design and substance of national park inventories: the complexity of the natural resource base, the geographical diversity of national parks, the diversity of potential information users and the planning and management process to which the information contributes. The number of environmental components about which data may be generated is essentially infinite as is their capacity to change substantively in terms of time and space. Rather than attempt to list some of the more relevant parameters, it is sufficient to know that decisions related to "what information will be collected?" *must* be directly associated with probable applications. Inventories, for a land management agency such as Parks Canada, are not academic exercises but practical means for ensuring informed management. The sheer volume of possible data and the extraordinary cost of collecting it should ensure practical rationalization of the procedure.

As of this writing, there are 28 National Parks in Canada which must be managed and which, therefore, have certain information requirements. They range from 44,000 km^2 Wood Buffalo National Park to St. Lawrence Islands National Park with less than five km^2. Obviously, the resource characteristics of the parks vary widely as do the kinds of uses and the style of management applied. Total annual visitation has been used in the past as a measure of relative resource pressure, however 500,000 visitors to a 16 km^2 park can have considerably more impact than 2,000,000 visitors to a 6,800 km^2 park depending on the pattern of use. But visitors/km^2 is not in itself a reasonable measure since impact relates largely to sensitivity of the resource, the kinds of uses or activities and their distribution throughout the park area. It therefore seems a reasonable supposition that decisions regarding exactly what

information must be collected for each park cannot be based on some apriori formula but must be determined subsequent to an evaluation of the characteristics of the individual park and the anticipated levels and types of uses.

After some eight years of experience in the intensive inventory business, one notion appears to be emerging above all others as an operational precept or guideline to dictate inventory design. The product must be oriented to the needs of the user. There are seven major groups of users in Parks Canada who require information from the NRSP. These user groups and their responsibilities by order of NRSP service priority are:

a) *Resource Management Planners* - who have the responsibility to develop conservation strategies to maintain or enhance the natural resources;

b) *Master Planners* - who have the task of directing the integration of proposed interpretive, visitor use and other facilities proposals into a long term park management stragegy;

c) *Park Managers* - who have the responsibility of providing day-to-day conservation of the natural resources as well as monitoring natural and artificial changes;

d) *Interpretive Planners* - who must provide proposals and subsequent plans detailing the form and direction of the park experience;

e) *Engineers and Architects* - who have the responsibility to provide design criteria and construction guidelines;

f) *Interpreters* - who must impart the park theme and selected relationships within and between the natural resources compo-

AN INFORMATION MATRIX FOR NATIONAL PARKS

Level of Information Required	Land Region and District						Land System						Land Type					
Sub-Activity or User Information / Type of Information	Systems Planning	Master Planning	Resource Conservation	Interpretation	Visitor Services	Engineering	Systems Planning	Master Planning	Resource Conservation	Interpretation	Visitor Services	Engineering	Systems Planning	Master Planning	Resource Conservation	Interpretation	Visitor Services	Engineering
Economic					●			●			●			●			●	
Cultural/Social			●	●	●											●	●	
Historical	●		●	●			●	●								●		
Archaeological							●	●	●	●						●		
Flora	●							●	●	●					●	●		
Fauna	●							●	●	●					●	●		
Limnology				●					●						●	●		
Hydrology	●		●	●				●	●							●		●
Climatology	●		●	●				●							●			
Pedology				●				●	●			●			●	●		●
Geomorphology	●							●	●	●		●			●	●		●
Geology	●	●	●	●		●						●				●		

Table 1: Minimum Information Detail by User Groups and Discipline

nents and human culture to the park visitors;

g) *Systems Planners* - who on the basis of natural regions and features, identify suitable areas for inclusion into the National Park System.

In addition to the internal information users, there are often external agencies or individuals for whom the data are valuable. Lacking a research mandate save insofar as it contributes to the effective management of the national parks, external information applications are generally not considered in the inventory design with such uses therefore becoming an ancillary benefit accruing from the product.

Table 1, *An Information Matrix for National Parks*, has been prepared to demonstrate the relationship been the various generic classes of resource information and Parks Canada users. Although "level of information required" is primarily intended to illustrate scale demanded, it may also be used to assess importance or impact. Needless to say, requirements vary from user to user based on application, importance, frequency of use, etc.

The final determinant of an information-generating procedure is the organization of the planning and management process receiving the information. It is such a process which dictates what is required, by whom, when or how frequently. Figure 1 is a schematic presentation of how the Resource Management Process for a National Park might function, the discrete activities involved and the sequence in which they are carried out. Descriptions of each stage in the process indicate the form of any products which the stage demands; the decisions (in a general sense) which are required and, therefore; the data that are required to service those decisions. Attaching time frames to the process is also a necessity in order to ensure that discrete functions coalesce into an integrated whole at the appropriate time.

Thematic Approach vs Biophysical Land Classification

Initially, the thematic approach consisting of the preparation of individual inventories for each environmental component was the only strategy available to govern data collection in the parks. This approach offered the advantage of providing detailed information on individual resources which could be directly related to user requirements. Levels of comprehension could easily vary from project to project and user understanding, by virtue of methodological tradition, would be enhanced.

On the other hand, the thematic approach was relatively expensive, time consuming and logistically awkward. Projects were organized and administered separately, logistical support costs duplicated and, usually, they were conducted sequentially rather than concurrently.

Its failure to integrate, coreference and synthesize collected data was, perhaps, the most serious shortcoming in the approach. Multiple studies on different components generated immense volumes of material, separately presented and most often geo-referenced in incompatable fashions. Certainly, much additional work was required to ensure that some notion of resource inter-relationship was derived from the studies.

The Biophysical Land Classification* approach (Subcommittee on Biophysical Land Classification, 1969) suggested a suitable strategy to resolve various planning difficulties. This alternative could offer a global view of a park and present data to users in an integrated form using ecological units. By studying the environment as a whole, it could provide useful information more quickly and at a lower cost than would the thematic approach. Unfortunately, Lacate did not provide specific instructions for operationalizing the BPLC concept.

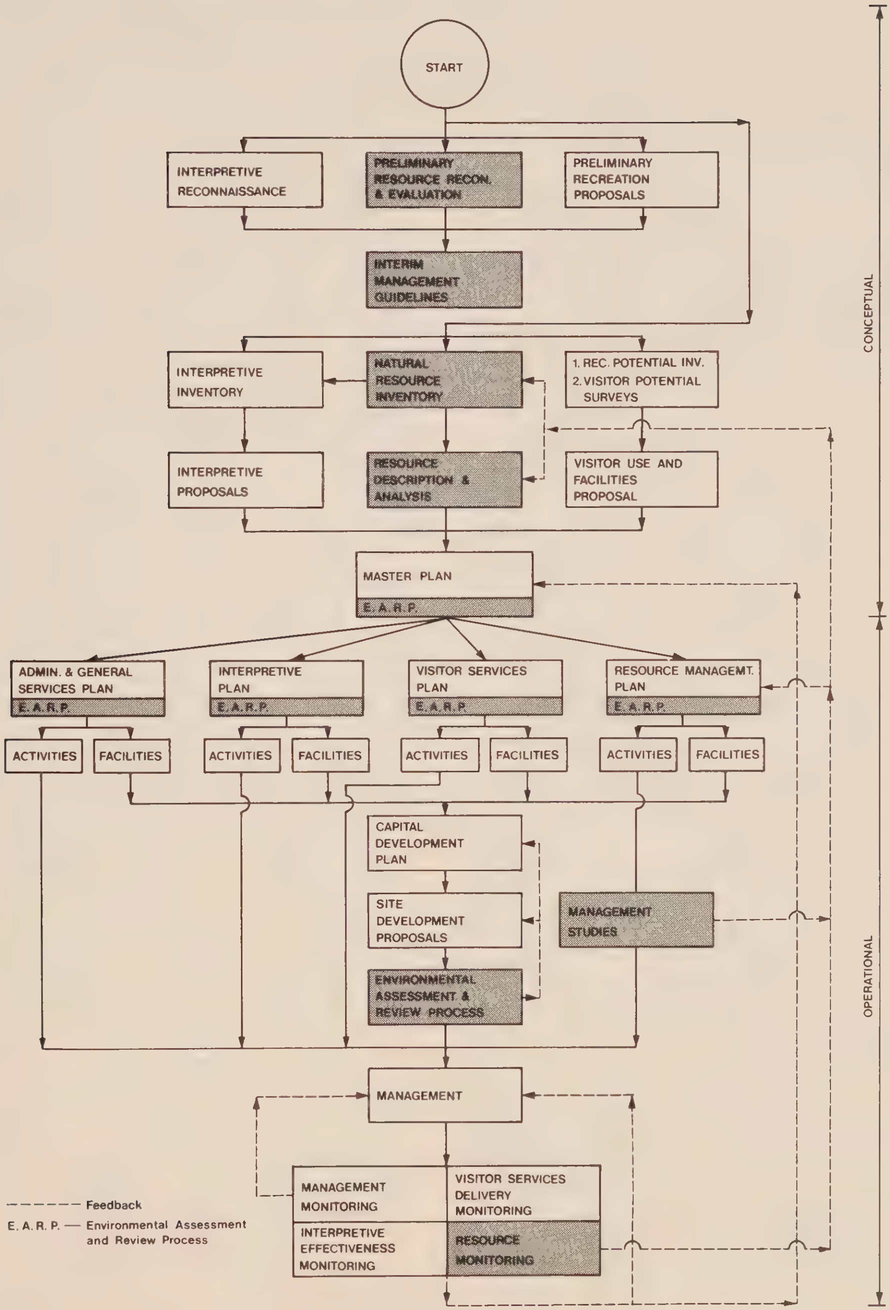
THE EVOLUTION OF BPLC IN PARKS CANADA

The biophysical approach to classifying and recording National Park resource information gained initial acceptance by the Ottawa based Resource Inventory group in 1971. Regional Office staff responsible for the design of specific Park studies launched initial 'integrated' inventory projects as early as 1972. Acceptance of concepts advocated in Canada by Hills (1961) and subsequently expanded in *Guidelines* (1969), was largely based on the perceived advantages of integrated field mapping and data description.

In specific terms, the benefits were seen to include: the creation of only one map

* Note: Since our approach seems more biophysically oriented than ecologically based, we have chosen to adhere to the original terminology rather than use the more recent term 'ecological land classification'.

Figure I: RESOURCE MANAGEMENT PROCESS



to describe several resource types previously mapped individually, the ability to use a single set of terms of reference to hire a team of specialists; and potential savings in dollars and time. At this stage very little thought was given to the design of classification criteria, to the presentation format, or to applying a hierarchical approach to acquiring information. It was also generally assumed, although never stated, that other resource types such as wildlife, would be readily integrated at a later date.

During this initial move toward BPLC activity, several studies were initiated. The Forest Management Institute launched mapping programs in Kejimkujik and Fundy National Parks creating final maps which contained largely non-integrated data on forest types and soils and landforms. Atlantic Resource Planners were hired to transform older maps of the forest cover types of Kouchibouguac National Park into a 'biophysical' product. In Yoho Park, vegetation and physical resources were mapped and classified under separate contracts with hopes that through field consultations, subsequent integration would be possible. In no case was initial classification at the Land District or Land Region accomplished as a first step.

To Parks Canada, the lack of clear operational instructions in the 1969 *Guidelines* has had beneficial and negative effects. Certainly the flexibility in research design is vital to an agency with a mandate to manage diverse resources in Parks ranging in area from four to 44,000 square kilometres. On the negative side of the balance sheet, the lack of a consistent and clear understanding of the foundation concepts has resulted in the acquisition of resource information which is often difficult to apply, poorly organized and presented, and sometimes illogically classified. The rapid move to biophysical classification, prior to developing a clear understanding of required future applications is the underlying cause of this initial confusion.

During the latter half of 1972, and in 1973, recognition of the concept of a hierarchical approach to data acquisition and classification gained acceptance in some regions. Inventories initiated in Auyuittuq National Park by Gauthier, Poulin, Thériault Ltée., and in Gros Morne National Park by Airphoto Analysis Associates Consultants Ltd., are examples. Hierarchical structures and certain criteria for their recognition were formally laid out in terms of reference. In addition, the difficulty of slotting hard data needs into the classification structures was receiving greater emphasis. Experimental or pilot project classification was conducted in the Lake Louise area by the Environment/Agriculture Canada team headed up by Holland and Coen (Holland, 1976). Parks Canada was beginning to accommodate applications requirements in the biophysical designs, and the emphasis on classification alone as a final product waned. To this end, some effort in designing effective legends was initiated, particularly in Auyuittuq and Banff/Jasper National Parks. The role of the computer as an aid to storing, manipulating and retrieving data was also accepted, particularly in Banff, Jasper, Prince Albert, and Terra Nova National Parks.

Despite progress on some fronts, the problems of developing effective presentation formats, integrating hard data needs in the biophysical classification hierarchy, dealing with non-compatible information (i.e. archaeological resources), and developing updating principles and procedures had not been effectively resolved. In addition, locating research teams which could assemble documents useful for land management continued to be a difficult task. A further weakness of biophysical classification efforts of this period was the concentration on mapping present landscape conditions - the ecological element had yet to be recognized.

In 1974 considerable progress was made in the evolution of the Parks Canada system of biophysical classification and mapping. By this period, the difficulty in applying earlier biophysical data was being recognized and documented by users. For the first time resource analysts and park planners were attempting to use information and were becoming capable of iterating their needs for hard data. Although some projects were still being initiated along older lines, the Terra Nova, Cape Breton, Banff/Jasper and Prince Albert inventory programs marked substantial improvements. Concepts of dynamism in vegetation resources were, to varying degrees, accommodated by introducing the requirement that mapping teams develop successional models that incorporated a range of environmental considerations. The hypothesis that biophysical units could be used to describe potential wildlife habitats was being tested and more attention was being paid to data presentation formats. Each of these programs had its own inherent weaknesses, but as a system, Parks Canada was beginning to evolve some firm concepts. Variability in design criteria between regions was being reduced, largely as a result of improved communication. Table 2 outlines an up-to-date

listing of Parks Canada's activities noting for each study the area and level of detail and the study completion date.

At the present time, the concept of biophysical classification is firmly established. As new Park areas are tentatively identified, broad initial classification at the Land District and Region level is initiated by the Ottawa-based Natural Resources Division. Areas of special interest are classified at the Land System level. Specific information requirements are provided for each level of land classification. Although biological elements are included, the basis for classification at these levels is largely physical. This information is used to assist in the delineation of 'ecological' boundaries which are an important consideration in setting preliminary boundaries on proposed National Parks.

Parks Canada has accepted the fact that certain types of information cannot be readily depicted in terms of BPLC units. In recent years, work by the Canadian Wildlife Service in the Atlantic, Western and Prairie Regions has used BPLC units as the basis for sampling by quadrat or transect and for reporting the results of wildlife surveys. In the Ontario Region, efforts in St. Lawrence Islands N.P. (Bradstreet and McCracken, 1978), and in Pukaskwa (Skeel and Bondrup, 1978), have focussed on attempting to relate formats of habitat notation and designation to mapped BPLC units or groups of units. Similar work is being conducted by Karasiuk (1976) in Banff and Jasper National Parks. Difficulties arise in that different faunal groups have varying mobility; perceive the environment at multiple levels of resolution, and have behavioural patterns that alter seasonally. Researchers also have differing ideas of what constitutes a habitat. Bradstreet and McCracken's comparative analysis of avifaunal habitat clarifies some of these problems, providing a general procedure for relating habitat to BPLC units mapped by the Forest Management Institute in the Ontario Region.

Other types of information that are not readily depicted using BPLC boundaries include archaeological resources, point and line data of all types, and socioeconomic characteristics. BPLC boundaries and units can, however, be used to reference other information in a purely geographic sense, providing a mechanism for orderly access to a wider range of inventory data.

The move towards computerizing resource base data, and in particular the recent use of the Canada Geographic Information Systems to digitize the Gros Morne biophysical data, indicates that further refinements are required in the area of data presentation. Additionally, procedures of monitoring dynamism have yet to be adequately evaluated.

MANAGEMENT APPLICATIONS

It has been noted above and is reiterated here that practical land managers must apply resource data to resolve specific problems, and that the often academic exercise of classification is not an end in itself. Data collection for those who must make detailed decisions regarding the land is a frighteningly pragmatic exercise which must yield visible results if it is to be accorded the financial and manpower resources required for its support. The fundamental determinant in inventory design must, therefore, be the probable applications of the data in the management process, and the hard data they imply.

Although it may be said that probable applications determine the types of data to be collected, in reality, there is a potential application for any bit of information. How then does the inventory manager determine what should and what should not be collected? In theory, such a decision is based on a relatively complex relationship between the frequency and impact of decisions to be based on the data as compared to the costs of its acquisition, handling and retrieval.

Parks Canada, in order to assist in identifying BPLC and other information requirements, is moving toward use of a 'basic information required' approach which is loosely based on the notion that there is a geometrically incremental relationship between additional levels of detail and costs of acquisition. As a result of experience over the past several years, it is felt that there is a standard level of information required beyond which additional data collection must be specifically justified. Such justifications will be related to the idiosyncracies of the park under study but may include areas known to be particularly sensitive or significant, areas where development is likely to occur or populations which are likely to require special management such as rare or endangered species. Herein lies the principal benefit of the BPLC hierarchy.

Generally speaking, Parks Canada's resource information requirements tend to fall into four primary categories: planning, construction, management and interpretive/educational. Determination of information demands

Table 2: Biophysical Inventories in National and Historic Parks

NATIONAL PARK	AREA (km^2)	CONTRACTOR	DETAIL	TYPE OF PRESENTATION	COMPLETION DATE
Atlantic Region					
Gros Morne	1911	Airphoto Analysis Associates Consultants Limited, Toronto	Type	Report and Maps	1975
Kejimkujik	375	Forest Management Institute, D.O.E., Ottawa	Type	Report and Maps	1975
Kouchibouguac	223	Atlantic Resource Planners, Fredericton	Type	Report and Maps	1975
P.E.I.	18	Eastern Ecological Research, Truro	Type	Report and Maps	1976
Fundy	414	Forest Management Institute, D.O.E., Ottawa	Type	Report and Maps	1976
*L'Anse aux Meadows	129	Forest Management Institute, D.O.E., Ottawa	Type	Report and Maps	1977
Terra Nova	388	Gauthier, Poulin, Thériault Limitée, Ste-Foy	Type	Report and Maps; Computerized data bank and analysis	1977
Cape Breton	935	Eastern Ecological Research, Truro	Type	Report and Maps; Computerized data bank and analysis	1978
Quebec Region					
Auyuittuq (Part)	2330	Gauthier, Poulin, Thériault Limitée, Ste-Foy	System	Report and Maps	1975
Ontario Region					
*Fort St. Joseph	2.46	Airphoto Analysis Associates Consultants Limited, Toronto	Type	Report and Maps	1976
*Navy Island	1.19	Airphoto Analysis Associates Consultants Limited, Toronto	Type	Report and Maps	1976
Point Pelee	16	Houghs Stansbury and Associates Limited, Toronto	Type	Report and Maps	1976
Pukaskwa	1849	Forest Management Institute, D.O.E., Ottawa	Type	Report and Maps; Computerized data bank and analysis	1977
S.L.I.	4.14	Forest Management Institute, D.O.E., Ottawa	Type	Report and Maps	1978
G.B.I.	14	Forest Management Institute, D.O.E., Ottawa	Type	Report and Maps	1978
Prairie Region					
Riding Mountain	2926	Lombard North Consultants, Winnipeg	Type	Report and Maps	1976
Prince Albert	3293	Saskatchewan Institute of Pedology, University of Saskatchewan, Saskatoon	System	Report and Maps; Computerized data bank and analysis	1977
Nahanni	4691	Forest Management Institute, D.O.E., Ottawa	Type	Report and Maps	1977
Wood Buffalo	44013	Airphoto Analysis & Associates Consultants Ltd., Toronto.	System	Report and Maps	1979
Kluane	21657	Douglas Geological Consultants, Vancouver	System	Report and Maps	1980
Western Region					
Pacific Rim	104	University of British Columbia, Vancouver	Type	Report and Maps	1974
Yoho	1295	Alberta Institute of Pedology, University of Alberta, Edmonton	System	Report and Maps	1976
Banff-Jasper	17232	Canadian Forestry Service, Edmonton, Alberta Institute of Pedology, University of Alberta, Edmonton.	System	Report and Maps; Computerized data bank and analysis	1981

will then be a function of the probable *decisions* to be made within the functioning of each category.

Planning

As Figure 1 will illustrate, planning for an organization such as Parks Canada will occur at a variety of different temporal levels - long term, mid term and day to day. Under most circumstances, the temporal designation of the planning level will also designate levels of detail and, to a lesser extent, urgency of data requirement. Thus the long term Master Plan will reflect a larger scale approach (1:250,000) with a lengthy period to anticipate and respond to information demands. Mid-term management planning requires more detailed, often site-specific, data within a shorter time period while day to day crisis response suggests a need for problem specific data within hours. Planning attention in this paper will be restricted to the longer term variety.

The function of a Master Plan is to define, in broad terms, the purpose of the park, its role within the National Park system, its objectives and, very generally, the actions, activities and facilities required to meet those objectives. A central component of a Master Plan is usually a zoning map of the park dividing the park into up to five land use zones ranging from wilderness management areas to intensive use areas. The criteria used in zoning are largely subjectively derived, although usually based on some interpretation of natural resource characteristics.

A recent "decisions analysis" of completed Master Plans has suggested an information requirement roughly equivalent to the systems level of land classification with specific demands for data on the presence of rare or endangered species, representative or otherwise significant habitats or populations and areas which appear to be most suitable for use in the national park context. It also appears that most of the hard inventory data for those parks was not directly applied in the process. Further examination has indicated that effective application of inventory data in the master planning process demands that the data be subject to primary and, in some cases, secondary interpretation prior to being passed to the planner. This, in turn suggests that inventory design should include allowance for interpretation.

An excellent example of biophysical land classification being applied in a park inventory context is provided in Holland (1976). The methodology applied in that project combined with automated handling of the data by the Soils Research Institute has conferred a capability to rapidly generate interpreted output for contribution to the planning process. Such primary interpretations as soil texture, calcareousness, and per cent coarse fragments are immediately available and of obvious utility. A large number of secondary interpretations have also been generated by resource planners for the Bow Valley corridor, identifying the capabilities, limitations and special characteristics of the land from a national park perspective.

A note of caution is required. Recognizing that the utility of the biophysical land classification framework can only be optimized through decision-oriented interpretations of the data, increasing use of terms such as capability, sensitivity, suitability, vulnerability, etc. will force additional confusion upon a population of already confused land managers. Much work has been done on soils data models for engineering purposes; however the bulk of land management interpretive potential lies outside the soils/engineering realm. Each preferred interpretation should be subject to careful user scrutiny to determine validity.

Construction

Reference is made above to soils interpretations for engineering purposes. This type of application represents one of the best and most direct uses of biophysical data at the land type and land phase classification levels. The parameters involved and the procedures which might be followed are summarized in a variety of sources including Coen and Holland (1976) and the USDA (1971).

For other purposes, the construction and development function demands a level of information sufficient to understand or predict the environmental implications of a development proposal and to enable informed decisions to be taken which ameliorate those which are judged to be significantly adverse. Data are required for specific sites or corridors and for projected zones of influence around the sites or corridors. If, during the inventory design stage, the probable locations of development are known, then the stratified or hierarchical nature of the BPLC framework lends itself admirably to the collection of relevant data at the required level - but only for the potentially affected areas.

A general inventory, no matter what scale is used, will never eliminate the need to con-

duct project-specific environmental impact assessments (EIA), however, in a detailed assessment, as much as a year might be saved due to immediate data availability. This time saving is of particular significance inasmuch as the EIA continues to be regarded by most land managers as an onerous and time consuming requirement.

Management

The difficulties in making detailed observations on the relationship between biophysical data and management applications are immense - if only because the range of potential applications are themselves immense. The types of resource problems to be found in any given park depend on a wide variety of factors including the characteristics of the natural resource base, the type and intensity of park use, the location and nature of park facilities and use of adjacent land. At least four generic classes of problems exist - wildlife, vegetation, geophysical and interdisciplinary.

Clearly, the solution of any problem or the meeting of a specified objective will demand data from diverse sources only a small measure of which will be available from even the most complete biophysical inventory. An example of data demand complexity may be observed in the increasingly frequent requirement to manipulate habitat in support of park ungulate populations. Historical fire suppression has, in many instances, led to a reduction in habitat with consequent herd stress. Prescribed burning has been introduced in order to increase or maintain forage availability. Not only does this management activity demand data on vegetation physiognomy, succession, and certain soil characteristics (each of which is amenable to the BPLC framework) but it also requires information on climate and faunal exploitation. The scale requirements of each bit of data may vary widely as might the frequency of its collection - related in part to component dynamism and in part to the nature of the application.

It will be noted that, although each management problem is addressed separately, a functional level of problem anticipation is necessary to ensure that data are available when needed. As indicated above, anticipation of all potential applications will not automatically determine data to be collected in a park inventory. Frequency of application will be a fundamental determinant in as much as the more frequent the use, the more cost effective it might be to collect the data in advance of specific problem indentification. Similarly, if the problem is of the less urgent variety, time may be available to collect data related only to actual elements of the problem. Diversity of scale and integrative relationships from one application to another also serves to focus attention on the need to clearly define potential applications of data as part of an inventory design procedure. Since the applications will vary widely from park to park, it then follows, that the inventory design and necessarily the relevent biophysical land classification framework must reflect substantial flexibility. This flexibility, in turn, increases the opportunity for application errors due to misunderstanding on the part of those responsible for classifying the land and also those who must interpret and use the data.

Educational/Interpretive

In the Parks Canada experience, the potential applications of natural resource data collected using a biophysical land classification framework are only now beginning to be exploited from an educational/interpretive perspective. From a practical standpoint, the function appears to have two discrete elements: scientific research and interpretation. The scientific research function of national parks is not well understood either inside or outside Parks Canada. A recent draft of the Parks Canada policy suggests two components which may be termed applied and scientific.

> "Research is essentila at all stages in the establishment, development and management of the national parks system. Parks Canada strives to learn about the natural environment so that national parks can be identified, protected and accurately interpreted to the public. In addition, research is important to assess public needs and the impact of visitor uses and facilities.
>
> National Parks also offer opportunities for basic research into natural environments which have not been substantially altered by human activity. As such, they serve as benchmarks for ecological research and for studies of the effects of modern technology on lands outside park boundaries".

The 'applied' research component is that leading to the planning, construction and management described above. The 'scientific' aspect, on the other hand, may well be the most directly useful application of biophysical data over the long term particularly in

benchmark studies. As a means of describing the status of the land in an organized and ecologically relevant fashion, the BPLC is an excellent tool. It enables the scientist not only to describe resources at present but also to select parameters which are amenable to the measurement of long-term change and to predict those changes on a unit to unit basis.

The biophysical land unit as a basis for prediction requires considerable attention before prediction becomes a viable management and research tool in that sense. Models must be devised which select the predictor variables and identify the response or dependent variables. In addition, the relationships between variables which are incorporated in the BPLC framework and those that are not must be carefully tested. The discussion on wildlife data incorporation above suggests some of the problems in this regard.

Interpretation of park resources to visitors also provides a potential application which is equally well suited to the BPLC framework. In the past, interpretation has been approached from a largely taxonomic perspective introducing visitors to individual plants and animals. Recently, however, the trend has been to interpret the park in terms of its processes and ecosystems. Since on-site interpretation is the most effective media, introducing the unit as ecotype and manifestation of process is extremely effective. Staff of Terra Nova National Park have utilized this approach in their interpretive planning with considerable success.

CONCLUSIONS

The concern of Parks Canada is the management of land in order to achieve various objectives. Given that concern, the foregoing paper generates a number of applications-oriented conclusions with regard to the BPLC.

1. The fundamental design criterion for any classification scheme must be the applications to which the data will ultimately be put. The final classification scheme(s) must clearly reflect a strong user orientation.

2. Similarly, diversity of appliction in the national park context will lead to diversity of classification structures. It therefore follows that considerable flexibility of approach must be maintained.

3. In light of the high potential for perceptual variation in understanding of classification criteria, clear operational guidelines are required to cover the procedure generally and each discrete application thereof.

4. Parks Canada experience over the past several years has shown that most users of data delivered in a bio-physical format lack the technical capacity to accurately interpret data significance. It therefore appears necessary to enhance the capability of the resource analyst to provide planning and management-oriented interpretations.

5. The present inability of the biophysical framework to adequately handle non-BPLC data must be overcome. Land management decision making is a multidisciplinary science demanding the highest level of information integration possible.

6. Resource monitoring and data update techniques must be developed in order to ensure the currency of inventories utilizing the BPLC approach.

REFERENCES

Airphoto Analysis Associates Consultants Limited. 1975. Biophysical Resource Inventory, Gros Morne National Park. 10 Volumes. Unpublished Report prepared under contract to Parks Canada.

Atlantic Resource Planners. 1971. A Report on the Surficial Deposits and Vegetation Cover, Kouchibouguac National Park. Unpublished Report prepared under contract to Parks Canada.

Bradstreet, M. and McCracken, J. 1978. Avifaunal Survey of St. Lawrence Islands National Park. Unpublished Report prepared under contract to Parks Canada by LGL Ltd.

Canada. 1974. Biophysical Survey of Kejimkujik National Park. Environment Canada, Forest Management Institute. Unpublished Report prepared for Parks Canada.

Coen, G.M. and W.D. Holland. 1976. Soils of Waterton Lakes National Park. Alberta Institute of Pedology, Information Report NOR-X-65, Edmonton.

Day, D. et al. 1975. A Multi-disciplinary Approach to Resource Inventory in National Parks. Unpublished Parks Canada Report, Calgary.

Gauthier, Poulin, Thériault Ltée. 1975. Parc national Auyuittuq; classification biophysique du col de Pangnirtung. Unpublished Report prepared under contract to Parks Canada.

Hills, G.A. 1961. The Ecological Basis for Land Use Planning. Ontario Department of Lands and Forests, Research Branch, Research Report No. 46, Toronto.

Holland, W.D. 1976. Biophysical Land Classification of Banff and Jasper *in* National Parks, pp. 221-238 Proc. First Meeting - Can. Comm. Ecol. Land Classif. (comp. and ed. by J. Thie and G. Ironside). Ecol. Land Classif. Series No. 1. Lands Directorate, Environment Canada. Ottawa.

Karasiuk, D. 1976. Interim Report on the Bird Inventory of Banff National Park. Unpublished Canadian Wildlife Service Report.

Skeel, M. and B. Bondrup-Neilson. 1978. Avifauna Studies in Pukaskwa National Park. Unpublished Report prepared under contract to Parks Canada.

Subcommittee on Biophysical Land Classification. 1969. Guidelines for Biophysical Land Classification. (comp. and ed. by D. S. Lacate) Canadian Forestry Service, Publication No. 1264, Ottawa. 61 p.

United States Department of Agriculture. 1971. Guide for Interpreting Engineering Uses of Soils. USDA, Soil Conservation Service, Report 0107-0332, Washington, D.C.

Walker, B.D. et al. 1976. Lake Louise Study Area - Biophysical Inventory. Northern Forest Research Center, Edmonton.

APPLICATION OF ECOLOGICAL (BIOPHYSICAL) LAND CLASSIFICATION IN THE ENVIRONMENTAL ASSESSMENT PROCESS: EXAMPLES FROM VARIOUS TYPES OF RESOURCE DEVELOPMENTS ACROSS CANADA

W. Eedy, K. Schiefer, J. Rowsell
and R. McCoy
Beak Consultants Limited
Mississauga, Ontario

ABSTRACT*

Examples from five recent Beak studies are discussed to illustrate the importance of ecological land classification to the environmental impact assessment process in Canada. These represent major developments from the Maritimes, Quebec, Ontario, the Prairies and the Arctic. They also include areas described by a varying sophistication of classification, from very little to the most detailed available. Recommendations are made concerning the future preparation, usefulness and avoidance of misuse of ecological (biophysical) land classification.

INTRODUCTION

Ecological (biophysical) land classification systems of various complexities and types have been utilized over the past number of years to produce maps and reports dividing portions of our country into recognizable ecological units. To complete these studies in an effective and utilizable manner requires much skill, time and money. To prepare biophysical maps of remote areas can require a team of specialized professionals and several years of field and office work with resulting costs of \$80 to \$200 per km^2 or greater.

Because of the time and expenses required to produce usable biophysical maps, it almost inevitably falls on the shoulders of the government to prepare them. In this current period of government austerity and make-or-buy policies, it becomes more and more difficult to justify such expenditures.

The authors have been involved in the preparation of biophysical and ecological maps over large scale wilderness areas; however we will leave the discussion of methodologies and results to others. Our paper is primarily oriented towards the practical application and value of ecological land classification in the expanding field of environmental impact assessment. At a time when major natural resource developments are being proposed in all regions of Canada, ecological baseline information of this type will prove invaluable not only to assessing the environmental consequences of development but also in evaluating future multiple resource use alternatives. The background of the philosophy of environmental assessments is outlined in Stone and Eedy (1977).

Although some of the major ecological classification studies are definitely aimed at predicting impacts of currently proposed projects (for example, Baie James, Mackenzie Valley and our own current Gull Island studies), one seldom has the time or resources to prepare a detailed classification once a development becomes committed. However, especially when large areas of land are to be used in the development, an accurate classification to a highly sophisticated level can be imperative. A good example of the problems and misunderstandings that can result from its absence is the current Reed Timber Limit study in Northern Ontario. It often becomes the responsibility of government groups to not only prepare accurate ecological land classifications, but to somehow predict the locations where these will be required. This must be done with enough forewarning to plan, budget and execute the study while political, economic or developmental schedules still allow the time. One of the major shortcomings of many traditional field studies in geology, pedology and biology is the artificial separation of these interconnected subjects. Ecological classifications attempt a reconciliation of these and other disciplines in a manner which presents an optimum of information in a compact formulation very suitable to the applied science of environmental impact assessment.

The following selected case histories are taken from past Beak environmental impact studies in several provinces. They cover a

* Pour résumé en francais voyez à la page 237.

range of geographical regions from arctic tundra to maritime tidewater and eastern boreal forest to prairie. As well, the studies involved a variety of major resource developments, including hydroelectric, forest harvesting and processing, and mining. They also reflect situations where existing ecological land classifications range from the most sophisticated level to almost superficial. They point out the value in having these studies completed prior to the project planning and development stages, but also indicate some of the problems of oversimplification when one is trying to lump large tracts of land into identical classification types. Hopefully, these case histories will help demonstrate the necessity and value of ecological land classification. At the same time they emphasize the care that must be taken in preparing a study which may never be duplicated or tested and yet could be the basis for decisions affecting thousands of square kilometers of untouched wilderness.

CASE STUDY NO. 1: DONOHUE ST-FELICIEN PULP MILL

The key environmental issues in this study revolved around the protection of Quebec's most important stock of landlocked salmon, (*ouananiche*) in Lac-St-Jean and its tributaries. Since the resolution of these issues has already received considerable attention (Eedy and Schiefer, 1977a; 1977b; Les Conseiller Beak Ltée, 1977), it will not be discussed further here. While much of the effort was focused on direct aquatic considerations, the potential long-term terrestrial problems of construction and operation of a major new pulp and saw mill complex in this region were also of significant concern.

The Saguenay Lac St-Jean region in which this pulp mill was to be built was described by Jurdant et al (1972) in one of our earliest and most extensive biophysical studies. The results of this study were invaluable to our report, allowing an efficient, quick and yet highly effective assessment of impacts on the terrestrial environment. Figure 1 depicts the ecological land types of the pulp mill area as classified by Jurdant et al (1972), and as simplified for graphic presentation in our own report. As illustrated by Table 1 (again, somewhat simplified from the Jurdant et al (1972) original), the land has been classified according to its capabilities for forest, agricultural and ungulate production, recreation, trafficability, risk of erosion, and engineering capability. By combining this with provincial airphotos, geology, soils and forest resource maps, with federal land use capability maps, with our own site investigations and literature reviews, the terrestrial portion of the study was completed effectively within the existing schedule and budget. Although we have emphasized that the Jurdant et al (1972) report was essential to our study, we would like to point out some of the potential dangers in excessive reliance on such a wide scale classification for interpretation of what are often very localized and site specific problems.

Erosion Risk

The site of the mill is near the bank of the Ashuapmouchouan (Chamouchouane) River. Jurdant et al (1972) classified this area as flat (0% to 3% slopes) with excellent trafficability, minimal to no erosion risk, and a medium to high capability to support engineering activities. This initially led us to believe that almost any reasonable engineering practices could be utilized in the construction without excessive harm to the local terrain. This was accepted readily since the mill was already under construction, any delay in schedule would be costly, and the emphasis of our ecological studies was directed towards solving fisheries concerns. To further emphasize this point, it should be noted that the Quebec Government's own studies of this mill (Dupont et al, 1977) only included the aquatic environment.

Our initial field studies immediately identified a significant concern: the banks of the Ashuapmouchouan at the site, far from being flat, had a shear drop of about 15 m to the waters' edge. The 'Parent' Series Podzols covering fine deltaic sands along this bank support a mature mixed forest. Several cuts to the river, for water lines and a proposed effluent system, already showed signs of erosion. Moreover, the low fertility of these sandy podzolic soils tends to restrict recolonization by protective vegetation. Our advice was immediately passed on to classify this as protection forest and avoid any further clearing. This advice would perhaps seem obvious to those at this particular meeting but it was not obvious to the construction contractors, nor was it obvious from the Jurdant et al (1972) study.

The second potential fallacy was a little more subtle. Geological investigations at the site indicated the granitic bedrock was covered by glacial till, followed by marine clays, fine deltaic sands, and the surficial

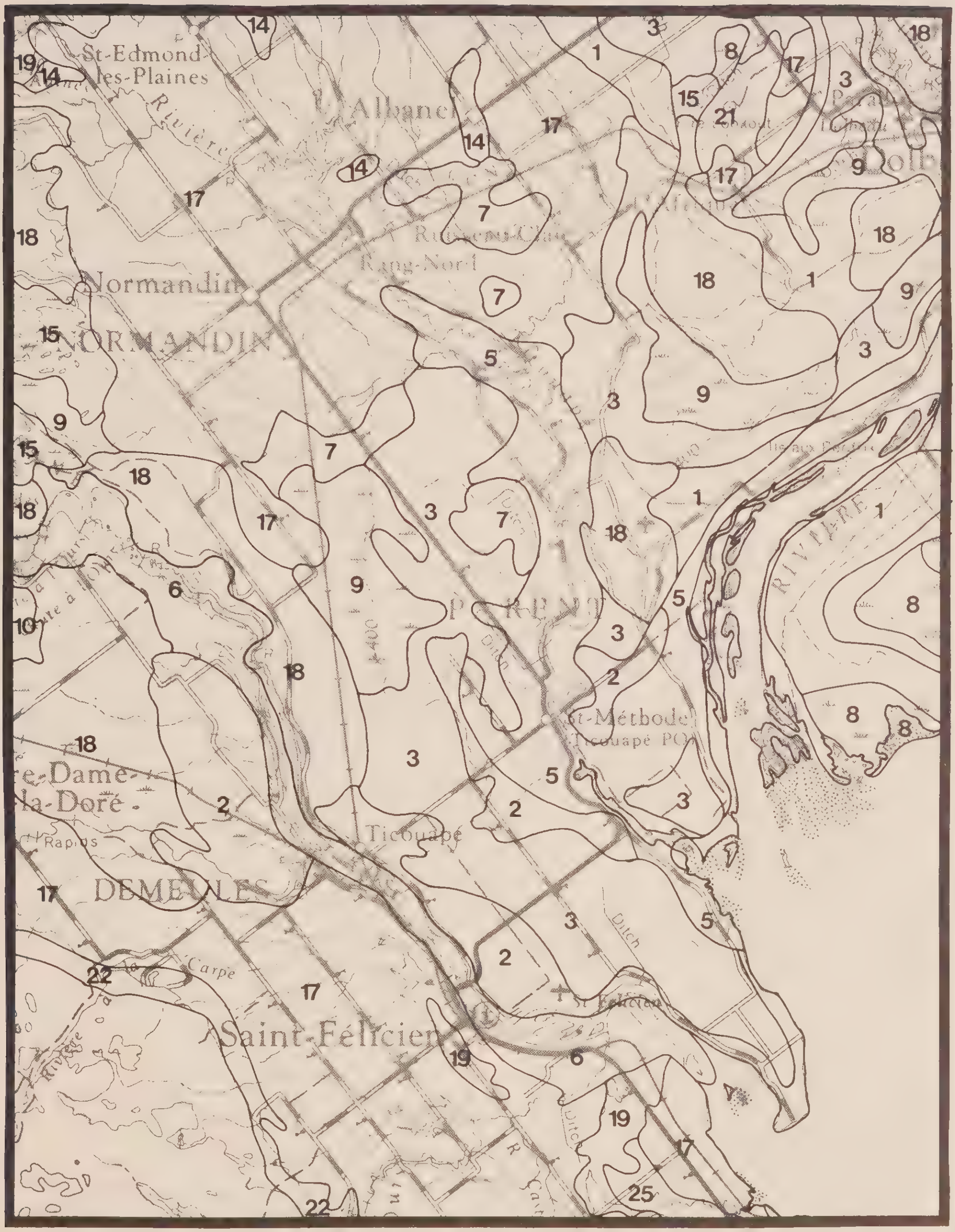


Figure 1: Ecological Land Classification of the St-Félicien Area (modified from Jurdant et al, 1972). See Table 1 for legend.

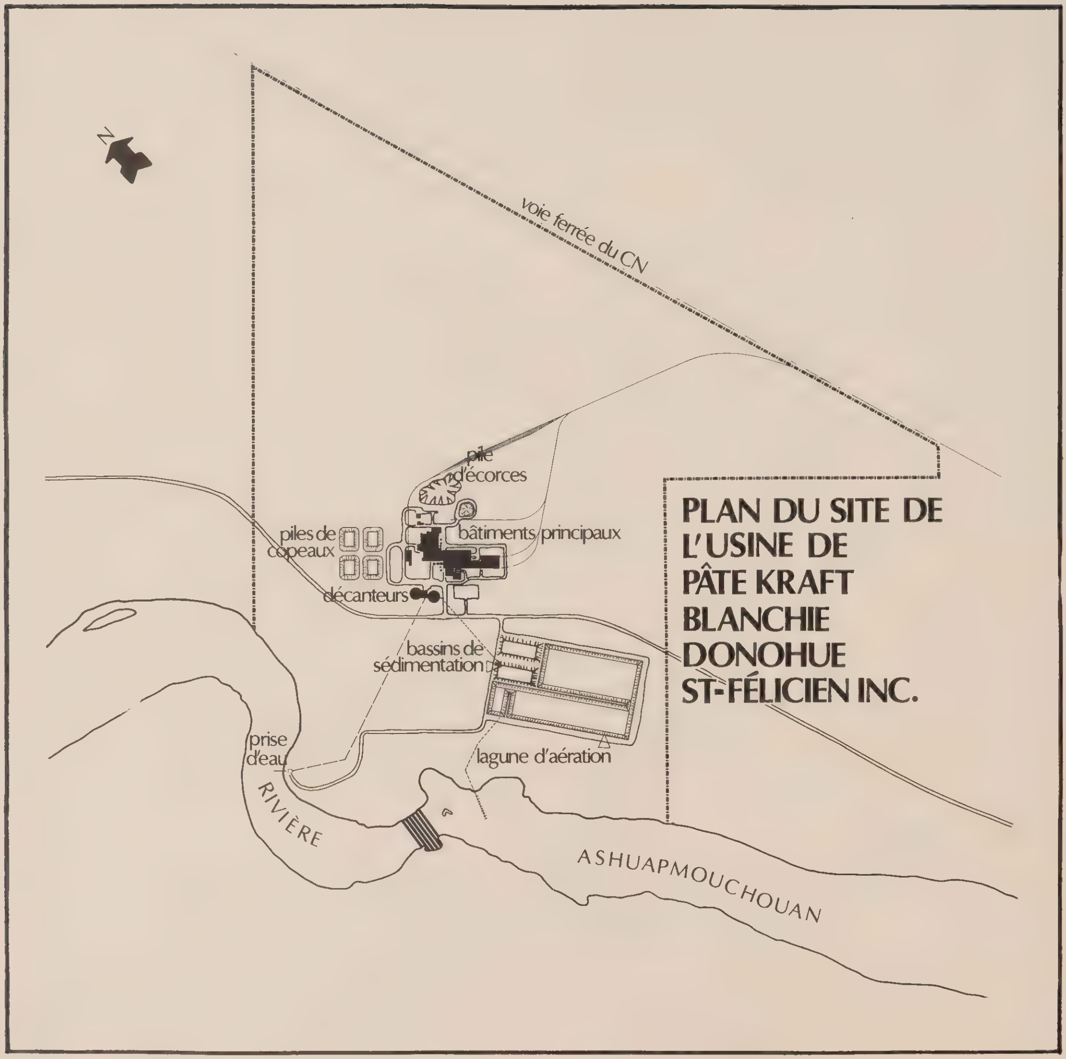


Figure 2: Site Plan for Donohue St-Félicien Pulp and Saw Mill, Québec

Table 1: Legend for Ecological Land System Map of St-Félicien Area

Land System No.	Ecological System	Forestry			Agri-culture			Recrea-tion	Ungu-lates	Engin-eering			Traffic-ability			Erosion Risk		
1	AF1-3-1-d	3	4	5	3	4	7	2	4	2	3	4	1	3	2	1	2	-
1	AF1-3-2-a	4	5	3	4	4	7	5	5	2	1	4	1	2	-	1	2	-
2	AF1-35#-1-a	3	4	-	3	4	7	5	4	4	3	5	1	4	3	1	3	2
2	AF1-35#-2-a	3	4	5	4	3	7	5	4	4	2	3	1	3	2	1	2	-
3	AF1-37-2-a	5	7	3	4	4	0	6	5	4	5	2	4	5	2	-	1	-
4	AF1-39-1-a	4	3	5	4	3	7	5	5	2	4	3	-	1	-	1	2	-
5	AF1-43-1-a	3	4	7	3	4	4	5	6	4	2	3	4	2	1	-	1	-
5	AF1-43-1-f	3	4	7	3	4	4	3	6	4	2	3	4	2	1	-	1	-
6	AF1-43-1-h	3	4	7	3	4	4	4	6	4	2	3	4	2	1	-	1	-
7	AF1-57-3-a	6	4	-	0	2	-	7	5	-	5	-	5	4	-	-	1	-
8	AF1-7-3-a	7	6	4	0	2	-	7	7	-	5	-	5	4	-	-	1	-
9	AF1-73-2-a	7	6	4	-	4	4	7	6	5	4	2	5	4	2	-	1	-
10	AF1-79-1-a	7	4	-	0	4	7	7	6	5	4	2	5	1	-	1	2	-
11	AH1-42-1-h	3	4	5	4	5	7	4	3	2	4	1	1	4	5	1	3	-
12	AR1-2-2-b	4	3	5	4	5	7	3	4	2	1	-	-	1	-	1	2	-
13	AR1-24-2-a	4	6	7	4	7	0	5	4	2	4	5	1	4	5	1	2	-
14	AR1-25#-1-a	3	5	-	3	4	2	4	4	4	1	5	3	1	4	1	3	-
15	AR1-97-1-a	6	7	4	7	4	0	6	6	4	5	-	5	1	2	1	2	3
16	AR7-05-1-a	6	3	7	7	2	3	6	6	5	4	-	5	3	4	3	1	-
17	AU1-5#-1-a	4	3	6	4	2	3	6	4	5	4	-	4	5	-	-	1	-
17	AU1-5#-2-a	4	3	6	4	2	3	6	4	5	4	-	4	5	-	-	1	-
18	AU1-93-1-a	5	4	-	4	7	-	5	6	4	2	1	-	1	-	1	2	-
19	AU3-50-2-d	5	3	7	2	7	3	3	5	5	4	-	5	4	3	1	3	-
20	AR7-02-1-b	6	7	4	7	4	4	5	6	5	2	4	5	1	4	3	1	-

The three columns under Forestry, Agriculture, Engineering, Trafficability and Erosion Risk indicate a complexed unit with more than one capability class present. The first column is most common. Exact figures are outlined in Jurdant et al (1972).

sandy podzolic soils. While in the Lac-St-Jean area, we made a short side visit to St-Jean-Vianney, the site of a disastrous landslide in 1972 resulting in considerable death and injury. It is obvious to anyone visiting the area that much effort has been made to forget this tragedy. But lessons must be learned from past mistakes. This was an area of fine sands overlying marine clays, with riverbank slopes very similar to the pulp mill site. Apparently, underground streams wetted the clay/sand interface resulting in the disaster. It was interesting to see houses going up in the area, once more perched on the edges of the scenic sandy cliffs. Many examples of such forgetfulness are repeated over and over in McHarg's (1969) classic *Design with Nature*.

In later discussions with project engineers, it was noticed that the part of the pulp mill complex closest to the river bank was the large effluent treatment lagoon (Figure 2). Interestingly, this was originally designed to allow seepage through the surficial sand layers. Whether this seepage would duplicate the St-Jean-Vianney underground streams, stimulate slippage at the sand-clay interface and result in the whole treatment system sliding into the river is probably doubtful, but with all the efforts and importance placed on protecting this river, such a chance could not be taken. Lining of the aeration lagoons was immediately recommended.

These two examples are not meant to downgrade the usefulness of the Jurdant et al (1972) report in any way. They are only made to emphasize the importance of carefully considering the scale and accuracy of a biophysical report before it is used and the need for site specific groundtruthing, no matter how well the original study was conducted.

Many beneficial results from the Jurdant et al (1972) study include:

- being able to predict bird and mammal populations of the mill area through application of this (and other local) classifica-

tions to species lists for the region;

- preparation of woodland operation environmental protection guidelines applicable to the types of habitat found in the area;

- development of general guidelines for the management and operation of the mill facilities with respect to the other biophysical land capabilities of the area.

CASE STUDY NO. 2: ELDORADO REFINERY, WARMAN, SASKATCHEWAN

Several types of land classification were available for this site. Soils maps and agricultural capability assessments indicated a moderate to low class 3 and 4 rating by the CLI system. These lands are used for forage crop production and rangeland and, in fact, almost half the site was not in agricultural use at the time of the study. This is a rather important criteria for several reasons:

(1) The proposed refinery layout can be modified so that the approximately 16 ha required for buildings will not include the more productive areas. This will allow continued forage cropping if the various regulatory agencies permit, and could become an excellent means of monitoring ground level concentrations of any emissions.

(2) The recent EARP Panel report concerning the proposed Port Granby refinery recommended that this Ontario site not be developed. One of the major reasons was the high class of agricultural land at the site.

(3) Local attitudes within a rural municipality in an agriculturally oriented province are strongly against industrial development of any of the higher classes of agricultural land.

Land use capability maps for recreational and wildlife potential indicated a lack of any special significance to this site. Following our initial field studies to groundtruth the classifications of these rather large scale CLI maps, we were able to direct the emphasis of our terrestrial studies into more essential areas. The government land classifications had thus allowed a quick overview assessment in areas of relatively minor concern, while a concentration of effort could be made in the most important aspects of the environmental assessment. The most important criteria for environmental safety of a uranium refinery concern the management of the radioactive wastes. I might emphasize at this point that the mandate of an environmental consultant is to objectively determine all the potential environmental costs and benefits of the proposed development, and wherever possible suggest the best methods to protect the environment. The Saskatoon area had been studied in some depth by Christiansen (1970). Maps in his study suggested the presence of a major groundwater system, the Tyner Valley Aquifer, at some depth under the site. This immediately raised the critical question and directed the emphasis of our research towards determining whether one can store or dispose of a low level radioactive waste, potentially active for 10,000 years, above the province's most extensive groundwater system.

Initially one would answer no, especially if this were based only on the preliminary information available in the Christiansen (1970) report. However, we conducted an intensive hydrogeological research program involving over 27 sets of test holes to depths up to 130 m, many sophisticated laboratory chemical, physical and bench-scale simulation experiments. This study, involving leading experts in this field who independently assessed the results, has provided a viable, and environmentally sophisticated waste management scheme far better than any in use or proposed to date. Since the scheme itself has already been presented at an earlier conference (Cherry et al, 1977), further related publications are in process, and since details of the research will be available shortly in our environmental assessment report, only a few of the important concepts will be outlined below.

Clay Tills - The Warman site is underlain by about 60 m of Sutherland Series clay tills. These tills have some of the lowest hydraulic conductivities measured. At the same time, these clays will retard any movement of radioactive materials because of their ion exchange properties. Our studies indicate waste materials could only move a short distance within the 10,000 year danger period, coming nowhere near the 75 m depth of the aquifer.

Water Dating - The tightness of the clays made it extremely difficult to obtain enough water to date by carbon-14 methods. The tritium dating and O^{16}/O^{18} ratios indicated old water at shallow depths, thus confirming our hydrogeological testing of the clays, but accurate numbers were not possible. Recent developments at the University of Toronto have allowed us to obtain carbon-14 dates of

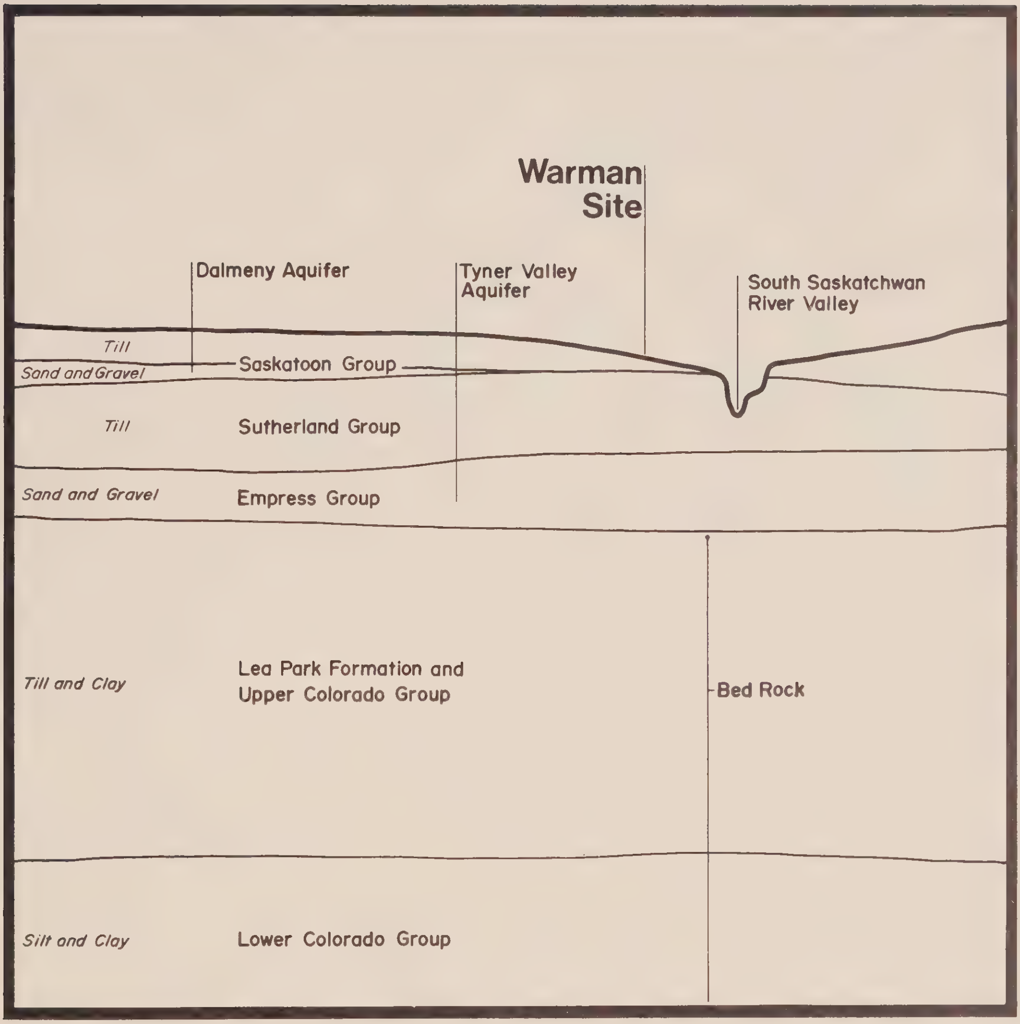


Figure 3: Stratigraphy of the Warman Area, Saskatchewan

small volumes of water. Using this system, we were able to date waters at 30 m depth at about 30,000 years B.P. This indicated that no water has moved through the till to this depth in that period of time.

Geological Overview - A report prepared for this study by Dr. Christiansen reviewed all geological records for the area. The interesting result from this is an indication that the thickest layers of this Sutherland clay till, which is most hydrologically appropriate for low level radioactive waste management, appear to only occur where underlain by major sand/gravel aquifers (Figure 3). Thus it appears that the site is justifiable from scientific or technical aspects. The preconception that this site would be unsuitable for low level radioactive waste isolation is related to the incorrect interpretation of an earlier preliminary and very broad scale terrain classification.

CASE STUDY NO. 3: INITIAL ENVIRONMENTAL OVERVIEW OF THE FUNDAY TIDAL POWER PROJECT

This initial environmental overview study, completed in 1977, emphasizes the importance of even very broad scale ecological land classification information to the planning and design of future studies of the environmental impact assessment format.

Much of the existing information concerning the three potential sites for a Fundy Tidal Power barrage was summarized at a conference in Wolfsville on 4 to 5 November 1976. The proceedings have been published (Daborn, 1977) and so will not be discussed in any detail at this time. Our own paper at this conference (Hodd et al, 1977) summarized portions of a report which had reviewed the existing ecological information relevant to the proposed development, and outlined the types of studies we and the many experts with whom we consulted felt would be required to determine if the development can be undertaken without extreme environmental repercussions. Some of the terrestrial aspects of this study will be summarized here as they relate to ecological land classification.

Agricultural Potential

The Canada Land Inventory capability maps for the upper Bay of Fundy indicated two important points. Much of the highest class agricultural land in this area is present due to the height of land or due to extensive dyking and *aboiteaux* drainage systems. These pockets of good farmland are surrounded by areas where poor drainage or salt intrusion have seriously reduced the agricultural potential of the land. Although the proposed develoment would not increase high tides above the barrage, it would decrease the tidal amplitude and natural low tidal levels by over 50 percent. The aboiteaux drainage systems include pressure valves which operate only at low tide levels when there is no tidal pressure closing them. This, plus potential groundwater/salt intrusion increases due to the higher mean tide levels, could result in significant agricultural problems.

Wildlife Ecology

Provincial maps of the salt marsh areas, the CLI land capability maps, Maritime Provinces sensitivity maps (Environment Canada, 1976) and reports presented at the Wolfsville conference (Hughson, 1977; Morrison, 1977) emphasized the importance of salt marshes and associated intertidal zones to a wide variety of terrestrial, shoreline and aquatic wildlife. Other discussions at the conference emphasized the basic lack of knowledge as to why these salt marsh/intertidal areas are so important to the ecology of the bay. By reducing the intertidal zone and tidal amplitude to half its normal level, will these ecosystems be significantly affected? The conclusions of the conference and our report both indicated far more basic research will be required. Initial land classification studies have been essential in determining the nature of potential problems and designing studies to assess them further.

CASE STUDY NO. 4: ENVIRONMENTAL FEASIBILITY STUDY OF AN ARCTIC MINE SITE

As proponents of future developments become more aware of environmental constraints, they also realize the importance of including environmental planning and overview ecological assessments in initial feasibility studies. A good example involved our work for Texas Gulf Incorporated in the vicinity of several potential base metal mine sites in the north-central Northwest Territories. These studies involved a collection of baseline ecological and socioeconomic information, preliminary environmental impact assessment, and also suggestions to avoid ecological problems during exploration. They also include the design of a full scale study to fulfill requirements of the various regulatory agencies

Figure 4: Aquatic Sample Sites, Caribou Migration Patterns and Other Wildlife Sightings near the Amooga Booga (Hood River) Study Area.

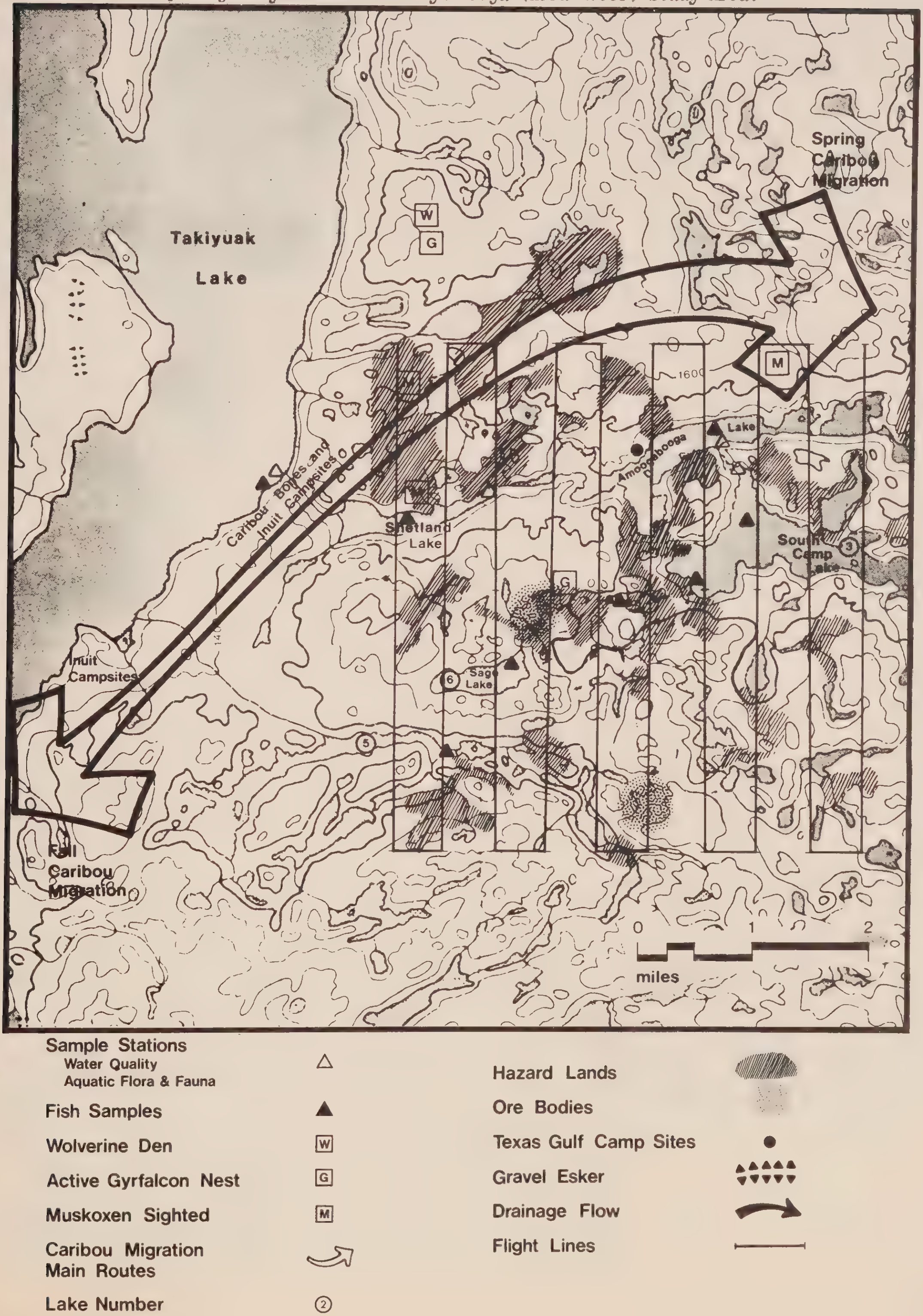


*Figure 5: Land Cover Map of the Bending Lake Region Southeast of Dryden, Ontario with Sitings of Power Transmission and Pipeline-Highway Proposed Corridors. **

LEGEND

Coniferous Forest	
Jack Pine (greater than 75%)	1
Black Spruce (greater than 75%)	2
Jack Pine/Black Spruce (combined greater than 75%)	3
Deciduous Forest	
Poplar/White Birch/Sugar Maple (combined greater than 75%)	4
Mixed Forest	
Jack Pine/Black Spruce/Poplar (together in all proportions exclusive of categories above)	5
Dominately Deciduous (Poplar/White Birch/Sugar Maple between 45-74%)	6
Dominately Coniferous (Jack Pine/Black Spruce/Red Pine/White Pine/White Spruce/Balsam Fir/Hemlock/Cedar together from 55-100% exclusive of above categories)	7
Other Land Cover Features	
Treed Muskeg or Barren/scattered Forest	8
Muskeg or Alder	9
Recently Cutover Forest Area	\\\\\\\\
Vegetation Sampling Quadrat	
Lichen Sampling Site	
Power Transmission Corridor	
Pipeline-Highway Corridor	

* Sources: OMNR Forest Resources Inventory Maps from 1965 data.
Reed Pulp and Paper Cutting Maps, 1965 photography.
OMTC Determined Alignments.
Map 2.36 S

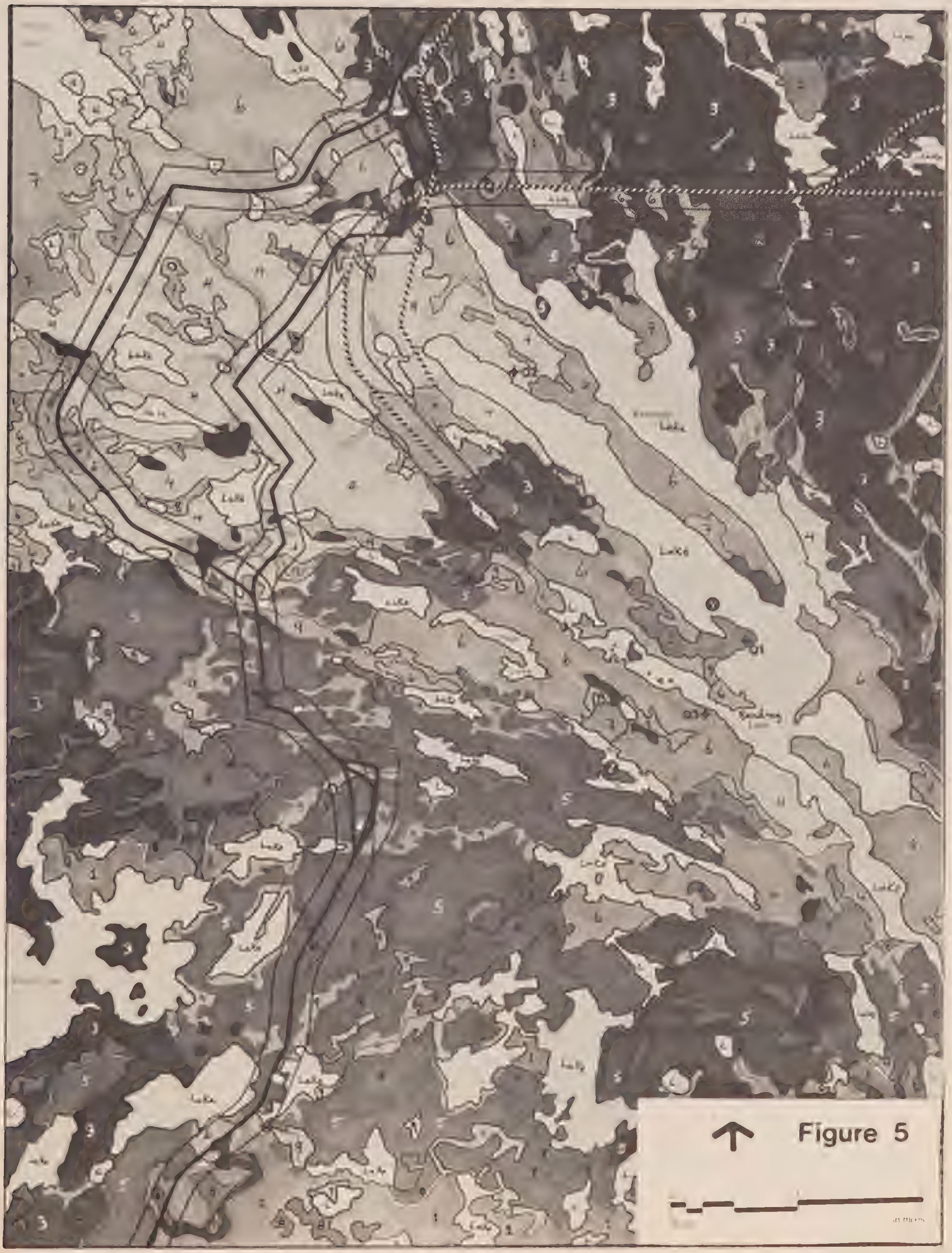


Figure 5

Figure 6: Unique Wild Rice Harvesting, Bird Nesting, and Uncommon Forest Areas in Area of Proposed Highway, Power, Pipeline Corridors Southeast of Dryden, Ontario.

Legend

Approximate Wild Rice Harvesting area
Potential Wild Rice Harvesting area
Fragile Areas M.N.R. Designation

Sensitive Bird Nesting Sites

- Bald Eagle nest
- Osprey nest
- Great Blue Heron rookery
- Potential Raptor Nesting site

Areas of Uncommon Forest Types

Red Pine ≥30%
White Pine ≥20%
White Spruce ≥30%
White Cedar ≥30%

Pipeline and Highway Corridor
Power Transmission Corridor


Dryden
WABIGOON LAKE
DINORWIC LAKE
WABIGOON RIVER
KAWASHEGAMUK RIVER
MENNIN LAKE
KAWASHEGAMUK LAKE
LITTLE MENNIN LAKE
SNAKE BAY
RALEIGH LAKE
Ignace
STORMY LAKE
BENDING LAKE
BEAK LAKE
KINMOAPIKU LAKE
SADDY LAKE
WABAGEJSI RIVER
SMIRCH LAKE
ISLETS LAKE
DIBBLE LAKE
PEKAGONING LAKE
JONES LAKE
RUTTER LAKE
CROOK LAKE
LITTLE GREYTROUT LAKE
WHITE OTTER LAKE
GREYTROUT LAKE
ELTRUT LAKE
MOUNT LAKE
CLEARWATER WEST LAKE
CROWROCK LAKE
DASHWA LAKE
FINLAYSON
FORSBERG LAKE
TURTLE LAKE
WILLIAMSON LAKE
MARMION LAKE
EYE LAKE
N TWIN LAKE
MOOSE LAKE
STEEP ROCK LAKE
ICY LAKE
LITTLE TURTLE LAKE
Atikokan
0 5 10 20
scale km
N

Figure 6

prior to development of the mine and its ancillary access, supply, housing, labour and other requirements. This type of study should become a requisite of future environmental approval processes and must rely heavily on biophysical land classification.

The isolated nature of this area has resulted in little information being available for it. Many sites in northern Canada with pending developments in the near future are similar to this site. Currently here the only available ecological land classification data, outside of some preliminary geological information (Money and Heslop, 1976), were the 1:1,000,000 *Arctic Ecological Series* maps produced by the Canadian Wildlife Services (1972). Even at this scale however, such classification is essential to the effectiveness of any preliminary overview study.

Figure 4 summarizes those types of information that can be collected by starting with a broad overview ecological classification, and applying four man-weeks of field time (including aquatic, fisheries, wildlife and socioeconomic studies). The site is close to a major migration route for the Bathurst herd of barren ground caribou. Geological barriers constrict their movements along Takiyuak Lake used to provide a setting for concentration of Inuit hunting. Numerous raptor nests were found along the cliffs bordering this lake. The drainage system east-west through the middle of the study area appears to be a barrier to the southward movement of muskoxen herds. The shallow surficial deposits do not place much restriction on local summer movements or campsites for exploration crews except in areas of significant wetlands. No major waterfowl or anadromous fish migrations occur in the area. Barren ground grizzlies, foxes, wolverines, etc., are found in the area. Almost all these data were implied by the CWS maps and only required localized groundtruthing to prepare our overview report.

CASE STUDY NO. 5: MINE SITE IN NORTHERN ONTARIO

This example demonstrates the use of ecological classification studies in the course of our environmental assessment of a proposed minesite in northwestern Ontario. Again, the method of synthesis of this information with the large quantity of data from other sources will not be described. Rowe's (1972) description of forest sections and regions in Canada is a general ecological scheme which initially informed us that the site is located at the transition the Great Lakes - St. Lawrence Forest Region and Boreal Forest Region. His descriptions fitted the species patterns described on Forest Resources Inventory maps and allowed an understanding of which associations were typical, which were anomalous and which might, through relative scarcity, be considered as potentially sensitive.

These and other existing information sources allowed us to summarize vegetation associations, to establish potential areas for ground surveys, to indicate potential areas of uncommon floral patterns, and to begin to understand how the non-homogeneous study area would be conducive to moose, waterfowl and other wildlife production, and to management efforts regarding terrain, flora and fauna. The graphic representation of the patterns was greatly facilitated by this on-hand wealth of ecological information (Figure 5). Figure 6 indicates how the Forest Resource Inventory data, as outlined in Figure 5, is combined with geological data, field surveys and information from government and literature sources to design a corridor avoiding unique or sensitive habitat areas.

SUMMARY

Impact assessment statements are not intended for the purpose of resolving philosophical viewpoints regarding the best manner of classifying a given area or regarding where to make divisional points. However, they are intimately dependent upon studies which have tried to resolve these questions. The quality of assessments quite obviously reflects the quality of the ecological classification schemes upon which our information is often based.

There are a large number of additional case studies which could be used to illustrate and emphasize the importance of Ecological Land Classification to the environmental assessment process. Some of these studies have been referred to by the regional reports presented at this meeting. Figure 7 outlines some of the more recent studies conducted by Beak Consultants Limited which have relied on such information to help direct our efforts and those of the development proponents in the most efficient and effective manner of protecting the environment. The following summarizes some of the essential points which must be considered by those who prepare and use ecological (biophysical) land classifications, as well as summarizing some of the

Figure 7: Sites of recent environmental assessments where Beak Consultants Ltd. has utilized biophysical land classification data in Canada.

most important ways in which such studies are used in the environmental impact assessment process.

Preparation and Use of Ecological (Biophysical) Land Classification Reports

(1) The large investment required to produce such reports and maps usually results in their information being unquestionably accepted by future users. Care must be taken to produce accurate, unambiguous results.

(2) The purpose, scale and scope of such studies can often lead to oversimplification or over-ambitious application of the results. Extreme care must be taken in report preparation to think about how the report will be used. Practical limitations and basic assumptions associated with the classification process should be well defined for future users. Groundtruthing should also be required before the interpretation of the existing classification is applied to environmental assessment.

(3) The value of ecological land classification can be great, but so can the cost and time commitments. Care should be taken in selecting areas to be classified to fit within long-range development planning for the area.

Applications of Ecological (Biophysical) Land Classification

(1) Initial route and site selection for a development.

(2) Design of ecological field studies.

(3) Allocation of specific site components and layouts.

(4) Selection of locations representative of the important ecosystem types in the area for detailed studies.

(5) Application of habitat use and capability studies to large areas.

(6) Environmental impact prediction.

(7) Environmental management design for an area.

(8) Design of mitigating measures to protect the local environment within the constraints of a proposed development.

(9) Preparation of Land Use Capability maps.

(10) Preparation of terrain constraint maps and reports.

(11) Recreational and land-use planning.

RÉSUMÉ

Le présent rapport traite de cinq études effectuées récemment par le groupe Beak, qui visent à démontrer l'importance de la classification écologique du territoire dans le processus d'évaluation des incidences environnementales au Canada. Les études portent sur de vastes projets de mise en valeur dans les provinces maritimes, au Québec, en Ontario, dans les Prairies et dans l'Arctique. Elles s'attardent également aux régions, qui sont décrites tantôt sommairement avec force détails. Le rapport fait aussi des mises au point sur la préparation, l'utilité et les dangers d'une mauvaise utilisation de la classification écologique (biophysique) du territoire.
(Trad. Éd.)

REFERENCES

Canadian Wildlife Service. 1972. Arctic Ecological Series. Maps and reports.

Cherry, J.A. R.W. Gillham, G.E. Grisak and D.L. Lush. 1977. A concept for long-term isolation of solid radioactive waste in fine-grained deposits. *in* Proc. Symposium on Management of Low-Level Radioactive Waste, Atlanta, Georgia, 23-27 May 1977.

Christiansen, E.A. (editor) 1970. Physical Environment of Saskatoon, Canada. N.R.C. Publ. No. 11378.

Les Conseillers Beak Limitée. 1977. Etudes des répercussions environnementales usine de pâte kraft blanchie Donohue St-Félicien Inc. Report published for Donohue St-Félicien Inc., Montreal, P.Q.

Daborn, G.R. (editor) 1977. Fundy Tidal Power and the environment. Proceedings of a workshop on the Environmental Implication of Fundy Tidal Power, Wolfville, N.S. 4-5 November 1976. The Acadia University Institute, Wolfville, Report No. 28.

Dupont, C.J. F. Richard, M.T. Vallee, and R.L. Gagnon. 1977. Etude de la rivière chamouchouane. Effets previsibles des eversements de l'usine Donohue St-Félicien Inc., sur la ressource eau et ouananiche. Service de Protection de L'Environnement Quebec.

Eedy, W. and K. Schiefer. 1977a. Donohue St-Félicien environmental impact study. Innovative assessment technology allows more accurate prediction. Can. Pulp and Paper Industry 30 (16): 14-16.

1977b. Environmental assessment Donohue St-Félicien Project: a relevant case study for the pulp and paper industry. *in* Proc. Environmental Improvement Conference Canadian Pulp and Paper Association. Moncton, 1-3 November 1977. pp. 51-57.

Environment Canada. 1976. Sensitivity mapping of the Maritime Provinces. Environmental Protection Service. Ottawa.

Hodd, S.L. R.W. Crippen, W. Eedy, K. Schiefe and R.H. Loucks. 1977. Environmental considerations of a Fundy Tidal Power Project. *in* Proc. Workshop on Environmental Implications of Fundy Tidal Power (ed. by G.R. Daborn).

Hughson, W.B. 1977. Fundy avifauna: an overview. *in* Proc. Workshop on Environmental Implications of Fundy Tidal Power (ed. by G.R. Daborn).

Jurdant, M. J. Beaubien, L. Belair, J.C. Dionne and V. Gérardin. 1972. Carte écologique de la région du Saguenay Lac-St-Jean. Environnement Canada Rapport d'information Q-F-X-31.

McHarg, I.L. 1969. Design with Nature. Natural History Press, Philadelphia.

Money, P.L. and J.B. Heslop. 1976. Geology of the Izok Lake massive sulphide deposit. Canadian Mining Journal (May): 24-27.

Morrison, R.I.G. 1977. Use of the Bay of Fundy by shorebirds. *in* Proc. Workshop on Environmental Implications of Fundy Tidal Power (ed. by G.R. Daborn).

Rowe, J.S. 1972. Forest regions of Canada. Canadian Forestry Service. Publ. No. 1300. Ottawa.

Stone, D. and W. Eedy. 1977. The role of the consulting firm in environmental impact assessment. Chemistry in Canada 29 (2): 19-20.

THE APPLICATIONS OF THE JAMES BAY ECOLOGICAL INVENTORY: A MANAGER'S APPRECIATION

G. Gantcheff, and P. Normandeau
James Bay Development Corporation
Montreal, Quebec

P. Glaude
Lands Directorate
Environment Canada
Ottawa, Ontario

ABSTRACT

The applications of an ecological survey conducted by the Service des Études Écologiques Régionales, Environment Canada on a 410,000 km² area comprising the river basins of the James Bay Hydro Developments are discussed. A survey of users, mainly administrators, planners, managers, and resource specialists from la Société de développement de la Baie James, la Société d'énergie de la Baie James, Hydro-Québec, and consultants to these agencies provide the basis for the analysis. Uses are grouped in seven categories: location of corridors, environmental impact studies, land use planning, resource management, environmental descriptions, background information and other miscellaneous applications. The application of ecological land survey data to each of these categories is discussed and a number of problems are identified. This study indicates that actual applications demonstrate that the James Bay ecological land survey can provide an excellent data base for the resolution of problems in each category, but due to problems that are largely external to the ecological classification itself, its potential for application has yet to be fully realised. The main barriers to a greater utilisation of James Bay ecological data have been the lack of validated interpretation keys, insufficient user familiarity with ecological land survey and unavailability of appropriate data or data handling facilities when such data were needed. As these problems are corrected, the ecological land classification should prove to be a most useful tool.

RÉSUMÉ

On traite des applications d'un inventaire écologique effectué par le Service des études écologiques régionales, Environnement Canada, sur un territoire de 410 000 km², comprenant les bassins riverains des développements hydroélectriques de la Baie James. Une enquête auprès des utilisateurs, principalement des administrateurs, des aménagistes, des gestionnaires et des spécialistes en ressources de la Société de développement de la Baie James, la Société d'énergie de la Baie James, de l'Hydro-Québec et des consultants auprès de ces agences, nous fournit la base de cette analyse. Les utilisations sont groupées en sept catégories: la localisation de corridors, les études d'impact sur l'environnement, la planification de l'utilisation des terres, la gestion des ressources, les descriptions des milieux, l'information d'ordre général et les quelques applications diverses. On traite des applications des données de l'inventaire écologique dans chacune des catégories, ce qui permet d'identifier un certain nombre de problèmes. On conclut que les applications présentes démontrent que l'inventaire écologique du territoire de la Baie James fournit une excellente base de données qui permet de résoudre des problèmes dans chacune des catégories. Cependant, la réalisation intégrale de son application ne s'est pas encore concrétisée, en raison de certains problèmes qui dépassent la classification écologique elle-même. Les principaux obstacles qui ont empêché une plus grande application des données écologiques de la Baie James proviennent de problèmes au niveau de la validation des clés d'interprétation d'une familiarisation insuffisante des utilisateurs avec l'inventaire écologique, de la non-disponibilité des données ou des moyens de les traiter au moment opportun. Lorsque ces problèmes seront résolus, l'inventaire écologique deviendra sûrement un outil des plus utiles.

INTRODUCTION

In the *Guidelines for Biophysical Land Classification* (Subcommittee on Biophysical Land Classification, 1969), the National Committee on Forest Land stated that the aim of the biophysical classification was to serve as the ecological basis for land use planning. Jurdant et al (1977) identified a series of objectives that are instrumental in reaching that goal. Their book *Inventaire du Capital Nature* (op. cit.) presents a detailed,

partial list of fourteen such objectives under the form of interpretive maps derived from the basic ecological map and suggests sixteen fields of utilization for the data generated by the classification.

It is with these objectives in mind that an ecological survey of the James Bay Territory was initiated in 1973. How does the classification live up to promise of being a planning and management tool; how does it behave when confronted with the daily reality of decision makers; has the data generated by the classification contributed significantly to the actions of administrators, land use planners and resource managers?

This document presents a synthesis of the information provided by numerous potential users, either administrators, planners, managers or resource specialists affiliated with la Société de développement de la Baie James (SDBJ), la Société d'énergie de la Baie James (SEBJ), Hydro-Québec and the various groups which act as consultants to them. These three crown corporations are responsible for the development of an area covering 410,000 km^2, representing 129 maps at a scale of 1:125,000. The SDBJ is mandated to look after the integrated development of the territory and its natural resources while the SEBJ and Hydro-Québec join their efforts to develop the hydroelectrical potential of the area.

This presentation of a manager's viewpoint has been subdivided into the following sections: 1) major fields of utilization, 2) problems encountered in using the data, and 3) conclusions. Our comments are based on actual applications of the information generated by the inventory and not on possible or potential uses. This being said, it is important to bear in mind that we are discussing the utilization of a tool which is still in the making and that the development of the area was already in progress when the first ecological reconnaissance began in the field.

MAJOR FIELDS OF UTILIZATION

The data generated by the ecological survey of the James Bay Territory served as an input to a wide variety of projects which, for the present discussion, have been grouped under seven headings, namely:

(1) location of corridors;
(2) impact studies;
(3) land use planning;
(4) resource management;
(5) environmental descriptions;
(6) background information for various resource studies;
(7) miscellaneous applications.

Before dealing with these actual utilisations, we will discuss briefly an important intermediate step: the development of interpretation keys. One of the major uses of the data has been to serve as the basis for the evaluation of the land, either in terms of productivity for various renewable natural resources, suitability for different uses, or constraints limiting development. In this context the development of interpretation keys is a fundamental step in the utilization of the ecological data. Its importance stems from the fact that it is often the link that will bridge the gap between the raw data as collected by the resource specialist and the needs of the user.

Thirty-three keys covering various aspects of engineering, wildlife, forestry, recreation and hydrology have been developed up to now and are regularly being updated or adapted on the basis of new findings (Table 1). Some of those keys provide a direct interpretation of the information given at the land system level. This is the case for all evaluations concerning the engineering sector where one, or a combination of a few descriptors, are used to assess the suitability or susceptibility of each land system for such things as trafficability, soil erosion, road construction, etc.

The same approach is used in the evaluation of the various potentials related to recreational use which are based exclusively on the general characteristics of the terrestrial and aquatic portions of the land system as given on the maps. The assessment of the productivity of the land for wildlife species proved somewhat more complex and required a more sophisticated approach. The relationship between the various species and the major components of the environment considered in the inventory first had to be established and documented before any attempt of generalization could be made. Therefore, the first step leading to the preparation of those keys was to compare the results of wildlife inventories with the different parameters used in the ecological classification. Major descriptors of the land systems could thus be identified and a first evaluation of the productivity of the land be made.

The evaluation keys for waterfowl, moose and beaver were based on inventory data already at hand while a special program was initiated

Table 1: List of Interpretation Keys for the James Bay Territory

ENGINEERING

- Terrain type for engineering purposes
- Soil drainage
- General suitability for engineering works
- Suitability for the installation of septic tanks
- Suitability for housing development
- Suitability as a source for road construction material
- Trafficability
- Susceptibility to erosion
- Susceptibility to landslide
- Susceptibility to sediment accumulation in rivers

WILDLIFE

Capability for:

moose	hare-lynx
beaver	otter
waterfowl	mink
whitefish	marten
northern pike	willow ptarmigan
yellow walleye	muskrat (in preparation)
brook char	grouse des savannes (in prep.)
togue	
ouananiche	

FORESTRY

- Capability for forestry
- Capability for immature mixed woods
- Capability for lichens
- Susceptibility to windfall

RECREATION

- Landscape aesthetics
- Recreation potential of aquatic ecosystems
- Capability for outdoor recreation

HYDROLOGY

- Turbidity
- Organic matter content

by the SDBJ to gather information on small mammals and other species (Bergeron et al, 1976).

The reliability of the various keys vary considerably depending mainly upon two factors: 1) amount of information concerning the species, 2) ability of the descriptors to reflect species behavior. At present many keys are still being perfected on the basis of new data. The value of some is being questionned, but already many have been applied to the user's satisfaction.

Location of corridors

The development of an area such as the James Bay Territory involves the construction of many roads and powerlines, and possibly in the future, railways and pipelines. The selection of corridors for these transportation facilities requires a good knowledge of terrain conditions, fragile features, zones where disturbances should be avoided and high potential areas where access would be desirable.

Ecological land classification is a tool particularly well adapted to provide the necessary resource information that is required in the decision making process concerning the best route for these facilities. Many corridor selection studies carried out on the territory have used the data generated by the ecological classification, some of them relying entirely on this type of information. The following three projects are typical applications in this field:

(1) Location of access corridors between the existing Matagami - LG-2 road and the three coastal communities of Eastmain, Nouveau Comptoir and Fort Rupert - (3 study areas totalling 2,000 km^2).

(2) Selection of a road corridor between the sites of LG-2 and GB-1 - (a study area of 19,000 km^2).

(3) Construction of a road and a railway to new mining site in the Matagami area - (a study area of 21,000 km^2).

The typical procedure used in this type of study first involved a preliminary corridor analysis on the basis of technical and economic factors, resulting in the identification of a limited number of alternatives. Second, a corridor selection analysis using environmental criteria was done on the different alternatives, resulting in the selection of the route which presented the optimum characteristics. The ecological data was used at both stages of the study.

The ecological units delineated at the land system level served as the basic cells against which all the information were recorded, and all the analysis were done, the optimum corridor being aligned through the agglomeration of the land systems presenting the highest desirable characteristics and lowest undesirable traits.

The following baseline data and interpretation keys are usually utilized in the evaluation process:

(1) relief;
(2) surficial deposits;
(3) abundance of streams;
(4) wetlands;
(5) terrain type for engineering purposes;
(6) susceptibility to windfall;
(7) susceptiblity to erosion;
(8) landscape aesthetics;
(9) miscellaneous potentials for wildlife.

Impact studies

Impact studies also represent a major field of utilization for the data from the ecological survey. In many aspects this type of application is similar to the one discussed previously and only a few additional comments will thus be made here.

In the James Bay territory, impact studies, as required by law, are now being made for all new developments. The input of the ecological data into these impact statements varies from very low to very intensive depending upon the size of the proposed development, its location, the components of the environment it will likely modify, and the availability of other types of information.

The biggest project for which an impact assessment is being prepared is the Nottaway-Broadback-Rupert (NBR) hydroelectric development. The combined drainage basins of these three rivers, two of which will be partly diverted into the third, total an area of 123,000 km^2. At present many groups are working on sectorial aspects of the study. Synthesis, including the overall evaluation of negative and positive impacts, will be completed at a later date.

The present state of the natural resources and traditional uses of the territory by the

natives, are the most important aspects of the impact statement. Although this information is not provided by the ecological inventory, the ecological data has been used to serve other purposes. For instance, available ecological maps and descriptions were consulted at the onset to provide a general overview of the area. Interpretation keys, most of them concerned with wildlife have also been used.

The extent of the utilization of the data will depend essentially on the reliability of those keys and on their ability to reflect a real situation. However, they will not be used blindly and they will be tested on small sites before they are widely applied. The SDBJ has already provided the NBR project leader (the SEBJ) with a computer listing of the various capabilities requested for each individual land system within the project area. A group is presently developing computerized mapping facilities for this area, an essential tool when dealing with such large areas and so many units.

It is thus too early to say whether the NBR impact assessment will use the data extensively. The means to permit an intensive utilization are being developed but the whole question now lies in the validity of the interpretation keys. Many other smaller scale impact studies have used the data intensively, some of them relying almost completely on this type of information. Such is the case with the development of the Desaulniers River, the LG-4 - Caniapiscau road and the Laforge river diversion. Developments covering small areas such as dykes and camp grounds make little use of the data mainly because these require site specific information at a level of detail which is not provided by the survey.

Land Use Planning

Land use planning for activities other than hydroelectric development is only in the initial stage on the James Bay territory. A general land use plan *Le plan d'aménagement* is presently being prepared for the territory but in view of its objective, which is to identify the broad orientation of future development, it will make little use of the data.

At that level of planning, all considerations such as the present state of the natural resources, traditional uses, land dedications as described in the agreement between the natives and the provincial and federal governments, constraints imposed by the hydroelectric developments, along with social and economic factors, have preponderance over the type of information generated by the ecological inventory. The ecological data will play a more significant role in the preparation of more detailed version of the plan. It will also provide a major input in the elaboration of regional and sub-regional land use plans. Among the other projects which have used the information of the ecological inventory, are the following typical examples:

(1) The identification of suitable sites for the establishment of a small town (5,000 inhabitants);

(2) A study aimed at determining the long term role of the town of Radisson;

(3) The evaluation of the suitability of the Lake Wescapis area as a fish and game and outdoor recreation area.

Resource Management

The use of ecological survey for resource management purposes is just beginning and to date only a few projects, all concerned with wildlife management, have made use of the data. Relationships between various wildlife species and land regions have been established and this knowledge will be used to assess and monitor populations.

At the land type level another series of relationships between present populations and habitat maps were identified. This type of information along with the various interpretation keys for wildlife capability will be used to assess the potential of the territory for outfitting facilities in an attempt to answer very practical questions such as the number of territories, their size, location and boundaries.

Two other studies concerned with the capability for beaver have made use of the data from the ecological survey. The objective of the first study was to determine accurately the beaver populations within the future LG-2 reservoir in order to plan for an intensive trapping program before the area is flooded.

In the second study, an alternative under consideration is the relocation of beaver populations from the future Opinaca Reservoir to other sectors within the Eastmain Reserve which have high potential but whose population have been overexploited.

Environmental Descriptions

The data of the ecological inventory and various interpretation keys are a popular source of information for the preparation of general descriptions of certain environments, regions or sectors of resource development.

Typical uses of this kind include:

(1) The description of the Amos - Matagami region, with a view to synthesizing all the information on the land and the natural resources of the area as a first step toward the preparation of a regional land use plan;

(2) The inventory of the LG-3 - LG-4 area involving the gathering of all data on the natural resources including present state and capability of ecosystems, to serve as the basis for an environmental impact assessment;

(3) the biophysical description of the lake Mistassini sector which will be affected by the NBR project.

In the latter project, the following information was used:

1) land system maps and descriptions, as a basis for the preparation of a detailed surficial deposits map;

2) original field notes on vegetation, for the preparation of a land type classification; original field notes on humus thickness then used to prepare a humus thickness map;

3) beaver capability key.

Data on the actual population of moose, caribou and various fish species were, however, preferred to information on capabilities which was judged inadequate.

Background information for resource studies

Since the ecological inventory is the only inventory done for the whole territory, its results are frequently used for any new project that is initiated. The type of information that users are looking for include the data provided at the land system level as well as the original field notes.

The following two projects show the range of data applications.

(a) The identification of peat deposits that will likely float after the filling of the LG-2, Opinaca and Caniapiscau reservoirs. Data used: classification of organic land types, original field notes.

(b) The classification of lakes in order to assess levels of productivity. Data used: surficial deposits, shoreline material, shoreline slope, abundance of streams, and wetlands.

In this type of application, the user is looking for very specific information that will be used together with other data, from a program designed to suit their particular needs. The land types as taxonomic units, the original field notes and preliminary morpho-sedimentological mapping are most often used.

First hand knowledge of the area contributed by the people who did the field work (le Service des Études Écologiques Régionales) often allows a first insight into an area or clarifies particular aspects.

Miscellaneous

One last project completes this schematic overview of the applications of the James Bay Territory ecological inventory. It deals with archeological studies that were carried out among the La Grande and Kanaupscow rivers.

In an effort to locate sites where archeological research should focus, an attempt was made to investigate the correlation between areas of high wildlife potential and the presence of native camping grounds. Land capability maps were produced for beaver, hare and ptarmigan; it was found that areas showing the highest combined potentials for these species corresponded, to some measure, to areas most frequently used for settelment. These results are only preliminary at this point but they have demonstrated that the approach is useful.

PROBLEMS ENCOUNTERED IN USING THE DATA

In the first part of this presentation we have described how the data has been utilised. This, however, reflects only one aspect since not all of the projects undertaken on the territory have made use of the information. For various reasons some potential users did not or could not utilize the data.

There are basically five reasons explaining non-utilization of the data:

1) the information was not available at the time it was required;

2) the degree of reliability of the interpretation keys was unknown;

3) the data was presented at a level of perception which is incompatible with the user's needs;

4) lack of information at the land system level on key components of the environment such as aquatic and riparian habitat and present vegetation cover.

5) the users did not have the necessary experience to handle the information.

The ecological survey was initiated in early June 1973 after the hydroelectric development of the La Grande River complex had started. Results of the inventory under the form of land system maps at a scale of 1:125,000 and manuscript description sheets were gradually transmitted to the SDBJ from 1974 up to early 1977. The computerization of this mass of information started in 1974 and the data bank became operational late in 1977. At the same time interpretation keys were devised and are still being perfected today while the synthesis reports are expected to be finalized sometime this year.

The sequence in which the information became available and readily usable had a strong bearing on its use or non-use for many projects. We are discussing the uses of a tool that is still in the making. This situation largely explains the reason why the ecological inventory did not play the role it could have played in the preparation of the first phase of the development plan of the area and in the environmental assessment of the NBR hydroelectric project.

The following compares graphically in a hypothetical time frame, the sequence of availability of ecological information at various levels of perception and the sequence of requirement for the same information in a comprehensive land planning process.

Figure 1 illustrates two model situations where the ecological information is available at the necessary level of perception for input in a comprehensive land planning process. Central to these two model situations is the fact that ecological overview or synthesis information and reports are available for the initial steps of the planning process comprising the preparation of a preliminary conceptual overview plan. At this general level of planning, only highly synthesized ecological information would be brought to bear on the matter.

Models A and B differ in their approach. The ecological survey Model A illustrates a situation where the investigations have proceeded from a detailed investigation to an overal synthesis. Conversely, Model B begins with an overview study and more detail toward inventory and classification which are carried out subsequently. Model A illustrates on idealised James Bay situation and Model B resembles the proces initiated in Labrador.

Figure 2 illustrates the actual situation in the James Bay Territory. The ecological land survey focussed initially on the definition of land systems and land types through extensive field work. The definition of ecological regions came later. The definition of ecological districts and the production of synthesis reports were viewed as final steps in the five year program.

The comprehensive land planning process was initiated before the synthesized data on land regions and land districts became available and before the computerized system for handling the mass of data at the land type and land systems level became operational. Consequently, the results of the ecological survey were hardly considered during the preparation of the preliminary conceptual overview plan. There is, however, every reason to believe that the more detailed data at the land type and land system level will be used very intensively in the preparation of final, detailed regional and sub-regional plans.

A problem which is related to the availability of the data concerns its handling. The whole territory is subdivided into 40,000 ecological units at the land system level, each being described by the general characteristics of the terrestrial and aquatic habitat along with an enumeration of the land types forming the patterns. At the moment the computer facilities of the SDBJ can only produce listings of individual or combined characteristics. The mapping of these must still be done by hand. This constitutes a major problem for any potential user when dealing with a large area and, in order to offset this drawback, the SDBJ is in the process of developing the necessary facilities that will permit computerized mapping of the data.

The second major problem concerns the degree of reliability of the interpretation keys.

Figure 1: Idealised Model Situations for Ecological Survey and Planning

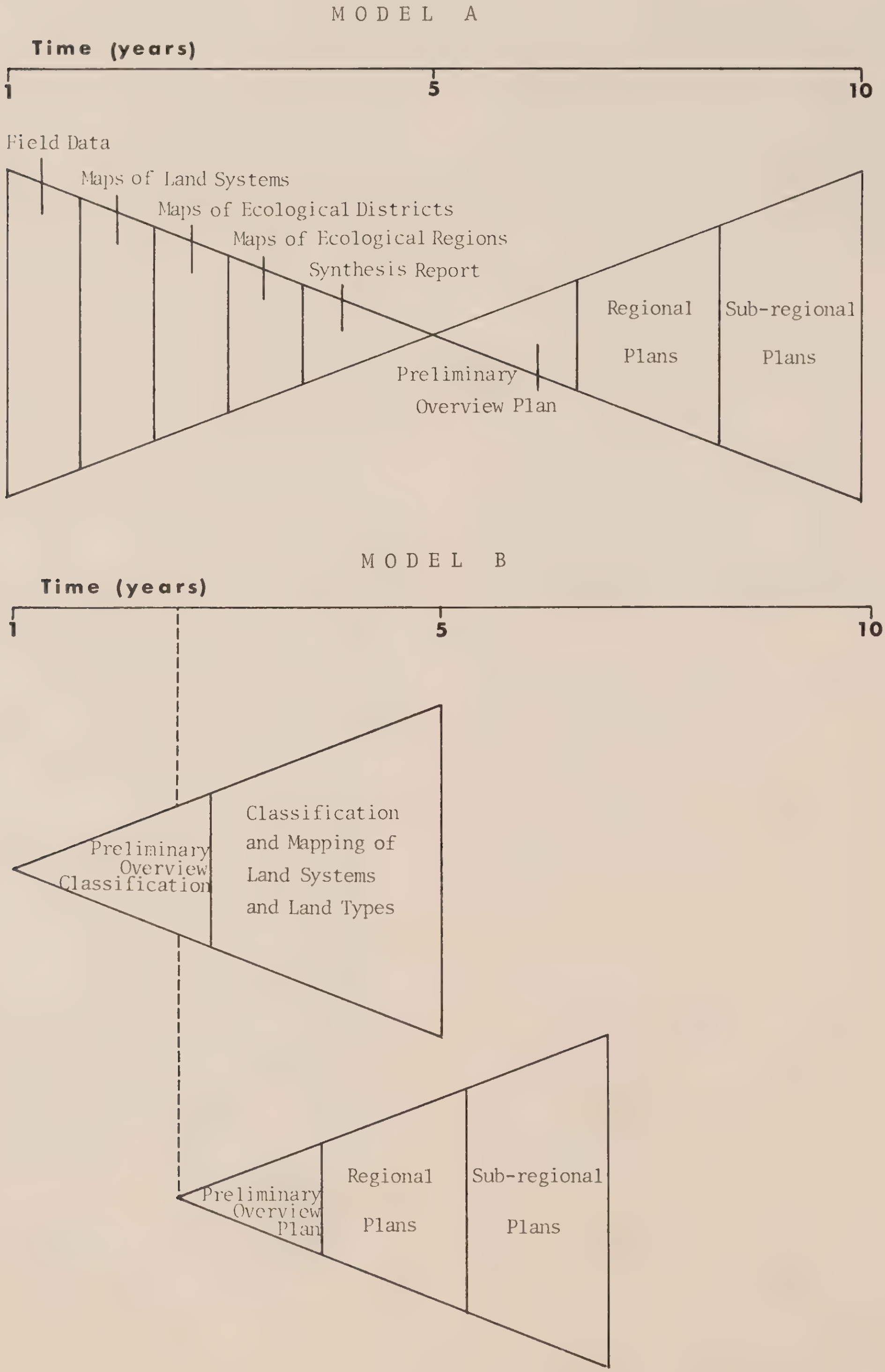
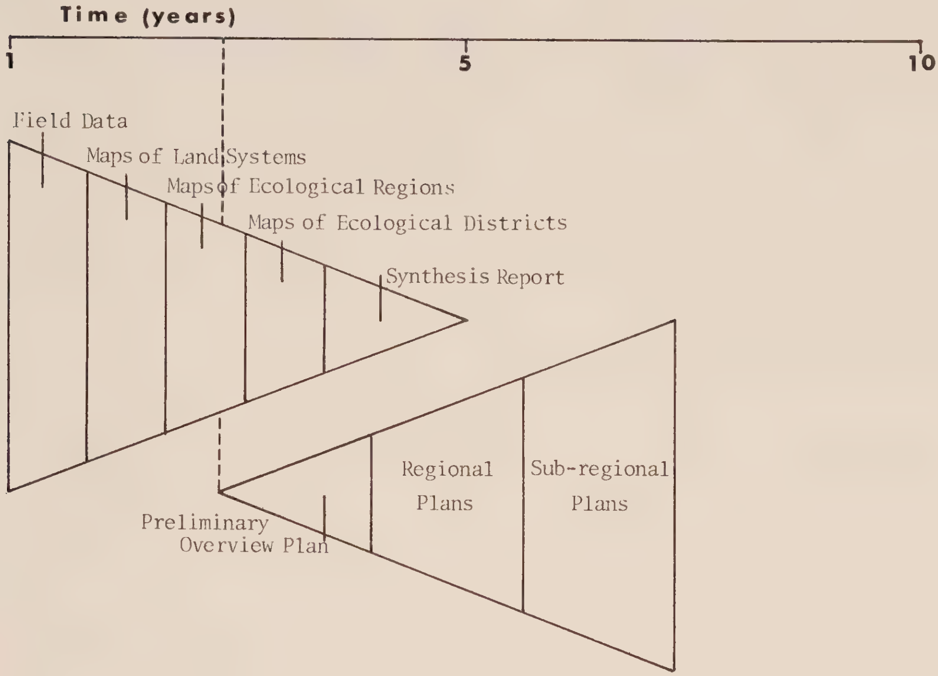


Figure 2: Actual Planning Situation in the James Bay Development Territory



In this respect, reactions from the various users of the keys ranged from great confidence to outright rejection. However, there is concensus among users to the effect that many of these interpretation keys have to be field tested before they are widely utilized. This validation process has already started and the degree to which a particular key reflects reality is becoming better known. This has led to a better understanding of the potential applications and limitations of such keys. These keys have a major role to play in the utilisation of the base data; the degree of confidence users have in them will determine the acceptance of ecological survey as a decision making tool.

The ecological survey of the James Bay Territory has put the emphasis on the gathering and presentation of biophysical data at the land system level mapped at a scale of 1:125,000. Although land types have been classified, no maps have been produced at that level of perception. A map of land regions was completed in 1976, but description of the land districts is not yet available. Up to now the data presented at the land region level has found little use other than the planning of an aerial wildlife survey. It has also provided the framework for a regional adjustment of some interpretation keys.

Discussions with potential users who found that the data presented at the land system level was too detailed tend to indicate that the framework of the land district would have been better adaptated to some of their needs. Indeed when trying to visualize the regional characteristics of a territory extending over 410,000 km^2, the level of the land system appears far too detailed and defies the human mind's capability to achieve synthesis.

Most users deplore the lack of integrated data on present vegetation cover which is a major environmental component and which constitutes essential information in many decision that have to be taken by managers.

Users in general feel that the classification of aquatic habitats, streams and wetlands did not receive the attention it deserves. These also constitute major components of the landscape and their description appears as important as that of the terrestrial portion of

the land. It is particularly significant to note that these habitats host many wildlife species for which attempts to develop capability keys were made. The poor performance of some keys is certainly a direct result of the lack of information on these habitats. Indeed to many users it appeared somewhat presumptuous to give the term ecological to an inventory which in their view devotes little attention to the description of aquatic habitat and where the present vegetation is not even considered.

The lack of emphasis on riparian habitats, whose presence conditions the distribution of many wildlife species, is also viewed by many as a problem. While most riparian habitats are identified at the land type level they are too often lost at the land system level since they rarely are identified in a land system.

It must also be said that the problems of data utilization are not found solely in the inventory itself. Very often the users themselves did not have the necessary background knowledge to be able to use the information effectively. It is particularly significant to note that many users view the results of the project as the mapping of land systems and know very little about the other aspects of the inventory.

In order to correct this situation the Service des Études Écologiques Régionales, which was responsible for conducting the inventory, held a number of seminars designed for maximum interaction between the inventory specialist and potential users in a simulated work situation. These proved to be useful but only a small number of users were reached.

CONCLUSIONS

It is clear that the information has been useful to a wide variety of projects ranging from archaeological studies to environmental descriptions and the evaluation of the capability of the land for the production of various renewable natural resources. Up to now the major uses have consisted mainly of corridor location studies, impact assessments and a number of other studies at the regional level.

We have found in the ecological survey a very useful tool which can contribute significantly to the decisions we have to make regarding resource development and environmental planning. However it is not the only type of information we need and it is not a substitute for some of the more traditional inventories which give information on the present state of natural resources such as the forests and various wildlife populations.

It is still too early to draw definitive conclusions as to the usefulness of this tool which is in its completion stage. Many completed or ongoing projects could have used the data but did not, simply because it was not available at the time those studies were initiated. The forthcoming years should thus prove better indicators of its true usefulness.

The extent of future applications will also largely depend upon the familiarity of the potential users with the classification, its results and their possible interpretations. Although a lot of time has already been devoted to show potential users how to use the data, it appears of the utmost importance that more workshops on applications involving potential users be organized.

The development of interpretation keys will also have to receive more attention in the future. These keys represent the point where resource specialists and users meet; the degree of confidence the latter has in the interpretation will determine the extent of the utilization of the ecological data.

In this presentation we have tried to give an appreciation of the ecological survey of the James Bay Territory on the basis of actual uses. Overall we feel that the ecological survey has been and will be very usefull and we would not hesitate to recommend such an undertaking if we were to start all over again. The fact that Hydro-Quebec, in cooperation with other agencies, is on the verge of reaching an agreement for a similar survey over a large portion of the St. Lawrence North Shore, is particularly significant and testifies to decision makers appreciation of this management tool.

ACKNOWLEDGEMENT

The biophysical data users survey on which this paper is based was conducted by Le Groupe Dryade Ltée for Environment Canada.

REFERENCES

Bergeron, R., J.M. Levasseur, J.M. Bélanger and J. Gingras. 1976. Évaluation du potentiel faunique du territoire de la Baie James. Proc. Sym. James Bay Environment. Environment Canada, SDBJ and SEBJ.

Jurdant, M., J.L. Bélair, V. Gérardin and J.P. Ducruc. 1977. L'inventaire du Capital Nature. Lands Directorate, Environment Canada, Quebec. 202 p.

Subcommittee on Biophysical Land Classification. 1969. Guidelines for Biophysical Land Classification (comp. and ed. by D.S. Lacate). Canadian Forestry Service. Publication No. 1264. Ottawa. 61 p.

LES APPLICATIONS DE L'INVENTAIRE ÉCOLOGIQUE DE LA BAIE JAMES: UNE APPRÉCIATION DE GESTIONNAIRE

G. Gantcheff et P. Normandeau
Société de développement de la Baie James
Montréal, Québec

P. Glaude
Direction générale des terres
Environnement Canada
Ottawa, Ontario

RÉSUMÉ

On traite des applications d'un inventaire écologique effectué par le Service des études écologiques régionales, Environnement Canada, sur un territoire de 410 000 km^2, comprenant les bassins riverains des développements hydroélectriques de la Baie James. Une enquête auprès des utilisateurs, principalement des administrateurs, des aménagistes, des gestionnaires et des spécialistes en ressources de la Société de développement de la Baie James, la Société d'énergie de la Baie James, de l'Hydro-Québec et des consultants auprès de ces agences, nous fournit la base de cette analyse. Les utilisations sont groupées en sept catégories: la localisation de corridors, les études d'impact sur l'environnement, la planification de l'utilisation des terres, la gestion des ressources, les descriptions des milieux, l'information d'ordre général et les quelques applications diverses. On traite des applications des données de l'inventaire écologique dans chacune des catégories, ce qui permet d'identifier un certain nombre de problèmes. On conclut que les applications présentes démontrent que l'inventaire écologique du territoire de la Baie James fournit une excellente base de données qui permet de résoudre des problèmes dans chacune des catégories. Cependant, la réalisation intégrale de son application ne s'est pas encore concrétisée, en raison de certains problèmes qui dépassent la classification écologique elle-même. Les principaux obstacles qui ont empêché une plus grande application des données écologiques de la Baie James proviennent de problèmes au niveau de la validation des clés d'interprétation d'une familiarisation insuffisante des utilisateurs avec l'inventaire écologique, de la non-disponibilité des données ou des moyens de les traiter au moment opportun. Lorsque ces problèmes seront résolus, l'inventaire écologique deviendra sûrement un outil des plus utiles.

ABSTRACT

The applications of an ecological survey conducted by the Service des Études Écologiques Régionales, Environnement Canada on a 410,000 km^2 area comprising the river basins of the James Bay Hydro Developments are discussed. A survey of users, mainly administrators, planners, managers, and resource specialists from la Société de développement de la Baie James, la Société d'énergie de la Baie James, Hydro-Québec, and consultants to these agencies provide the basis for the analysis. Uses are grouped in seven categories: location of corridors, environmental impact studies, land use planning, resource management, environmental descriptions, background information and other miscellaneous applications. The application of ecological land survey data to each of these categories is discussed and a number of problems are identified. This study indicates that actual applications demonstrate that the James Bay ecological land survey can provide an excellent data base for the resolution of problems in each category, but due to problems that are largely external to the ecological classification itself, its potential for application has yet to be fully realised. The main barriers to a greater utilisation of James Bay ecological data have been the lack of validated interpretation keys, insufficient user familiarity with ecological land survey and unavailability of appropriate data or data handling facilities when such data were needed. As these problems are corrected, the ecological land classification should prove to be a most useful tool.

INTRODUCTION

Dans le document *Guidelines for Biophysical Land Classification* (Sous-comité de la classification biophysique, 1969), le Comité canadien des terres forestières a établi que la classification du territoire visait à servir de base écologique à la planification de l'utilisation des terres. Dans l'ouvrage *Inventaire du du Capital Nature* (Jurdant et al, 1977), les auteurs ont établi une série d'objectifs qui peuvent atteindre ce but. Ils présentent une

liste partielle de quatorze objectifs de ce genre sous forme de cartes d'interprétation tirées de la carte écologique de base, et proposent seize domaines d'utilisation pour les données produites lors de la classification.

En 1973, ces objectifs ont servi de base au lancement d'une classification écologique du territoire de la Baie James. Dans quelle mesure la classification est-elle devenue un outil de planification et de gestion? Comment se comporte-t-elle devant la réalité quotidienne de la prise de décision? Les données produites par la classification entrent-elles de façon notable dans la démarche des administrateurs, des planificateurs de l'utilisation des terres et des gestionnaires des ressources?

Le présent document établit une synthèse des renseignements fournis par de nombreux usagers potentiels, soit des administrateurs, des planificateurs, des gestionnaires ou des spécialistes des ressources qui sont affiliés à la Société de développement de la Baie James, à la Société d'énergie de la Baie James, à l'Hydro-Québec et aux divers groupes qui leur apportent des conseils spécialisés. Ces trois sociétés de la Couronne sont chargées de l'aménagement d'une région couvrant 410,000 km^2, et représentant 129 cartes à l'échelle de 1:125,000. La SDBJ doit s'occuper de l'aménagement intégré du territoire et de ses ressources naturelles, tandis que la SEBJ et l'Hydro-Québec conjuguent leurs efforts pour exploiter le potentiel hydroélectrique de la région.

Cette présentation du point de vue du gestionnaire a été subdivisée en trois sections: 1) principaux domaines d'utilisation, 2) problèmes rencontrés dans l'utilisation des données; 3) conclusions. Nos remarques sont basées sur des appplications concrètes des renseignements produits par l'inventaire, et non sur des utilisations possibles ou éventuelles. Ceci dit, il est important de se rappeler que nous traitons de l'utilisation d'un outil qui en est encore à l'étape de l'élaboration, et que l'aménagement de la région avait déjà commencé au moment où les travaux de reconnaissance écologique ont débuté sur le terrain.

PRINCIPAUX DOMAINES D'UTILISATIONS

Les données produites par la classification écologique du territoire de la Baie James ont servi de base à une grande diversité de projets qui, pour la discussion actuelle, ont été groupés sous sept rubriques générales, soit:

(1) l'emplacement des corridors;
(2) les études d'impact;
(3) l'aménagement du territoire;
(4) la gestion des ressources;
(5) les descriptions environnementales;
(6) les renseignements de base destinés à diverses études des ressources;
(7) les autres applications diverses;

Avant de traiter de ces utilisations concrètes, nous aborderons brièvement une étape intermédiaire importante, l'élaboration des clés d'interprétation. Une des principales utilisations des données a été de servir de base à l'évaluation du territoire, du point de vue de la productivité de diverses ressources naturelles renouvelables, des possibilités de différentes utilisations, ou des obstacles pouvant limiter le développement. Dans ce contexte, l'élaboration des clés d'interprétation constitue une étape fondamentale pour l'utilisation des données écologiques. L'importance de cette étape repose sur le fait que les clés constituent souvent le lien entre les données brutes telles qu'elles sont recueillies par le spécialiste des ressources d'une part et les besoins des utilisateurs d'autre part.

Jusqu'à présent, on a créé trente-trois clés qui traitent de divers aspects des domaines de l'ingénierie, de la faune, de la foresterie, des loisirs et de l'hydrologie. Ces clés sont régulièrement mises à jour ou adaptées pour tenir compte de nouvelles découvertes (tableau 1). Certaines de ces clés fournissent une interprétation directe de l'information donnée au niveau du système écologique. Ce cas se présente pour toutes les évaluations concernant le secteur technique, où l'on se sert d'un descripteur ou d'une combinaison de descripteurs pour évaluer les possibilités ou les susceptibilités de chaque système écologique au regard de certains aspects comme la traficabilité, les risques d'érosion, la construction de routes, etc.

La même approche sert à l'évaluation des diverses possibilités liées à l'utilisation des terres pour les loisirs. Cet usage se base exclusivement sur les caractéristiques générales des parties terrestres et aquatiques du système écologique présentées sur les cartes. L'évaluation de la productivité du territoire pour les espèces fauniques s'est révélée quelque peu plus compliquée et a exigé l'emploi d'une méthode plus complexe. Avant d'arriver à un point de vue général de la situation, il a d'abord fallu déterminer et étayer la relation qui existe entre les diverses espèces et les principaux éléments du milieu examinés dans l'inventaire. Par conséquent, la

Tableau 1: Liste des Clés d'Interpretation

INGÉNIERIE

Types de terrain pour l'ingénierie
Drainage du sol
Possibilités générales pour les travaux d'ingénierie
Possibilités pour l'installation de fosses septiques
Possibilités pour la construction d'habitations
Possibilités en tant que source de matériaux pour la construction de routes
Traficabilité
Risques d'érosion
Risques de glissement de terrain
Risques de sédimentation des cours d'eau

FAUNE

Potentiel pour:

l'orignal
le castor
la sauvagine
le corégone
le grand brochet
le doré jaune
l'omble de fontaine
le touladi
la ouananiche
la lagopède des saules
le lièvre - loup cervier
la loutre
le vison d'Amérique
la martre
la rat musqué (en préparation)
le tétras des savanes (en préparation)

FORESTERIE

Potentiel pour la foresterie
Potentiel en matière de jeunes bois mélangés
Potentiel pour les lichens
Risques de chablis

LOISIRS

Beauté du paysage
Potentiel des écosystèmes aquatiques pour les loisirs
Potentiel pour les loisirs en plein air

HYDROLOGIE

Turbidité
Teneur en matière organiques

préparation de ces clés consistait à mettre en parallèle les résultats des inventaires sur la faune et les différents paramètres utilisés dans la classification écologique. On a donc pu identifier les principaux descripteurs des systèmes écologiques et établir une première évaluation de la productivité du territoire.

Les clés d'interprétation de la sauvagine, de l'orignal et du castor étaient basées sur des données d'inventaire déjà disponibles, et la SDBJ a lancé un programme spécial pour recueillir l'information nécessaire sur les petits mammifères et certaines autres espèces (Bergeron et al, 1969).

Le degré de confiance que l'on peut accorder aux diverses clés est principalement tributaire de deux facteurs, soit 1) la quantité de renseignements obtenus sur les espèces, et 2) l'aptitude des descripteurs à mettre en évidence les facteurs limitants qui influencent le comportement des espèces. A l'heure actuelle, de nombreuses clés subissent encore des modifications pour tenir compte de nouvelles données. La valeur de certaines de ces clés est mise en doute, mais on en a déjà utilisé un bon nombre à la satisfaction de l'usager.

Emplacement des corridors

L'aménagement d'une région comme le territoire de la Baie James exige actuellement la construction de nombreuses routes et lignes d'électricité, et peut-être la construction future de voies ferrées et de pipelines. Le choix des corridors destinés à ces installations de transport requiert une bonne connaissance des conditions du terrain, des zones plus sensibles où il vaudrait mieux éviter les perturbations, et des régions à potentiel élevé qu'il serait souhaitable de rendre accessibles.

La classification écologique est un moyen particulièrement bien adapté pour fournir les renseignements sur les ressources qui sont nécessaires aux choix relatifs à l'implantation de ces infrastructures. De nombreuses études effectuées sur le territoire en matière de choix des couloirs sont basées de façon exclusive dans certains cas, sur les données produites par la classification écologique. Les trois projets suivants en sont des exemples types.

(1) L'emplacement de corridors d'accès entre l'axe Matagami - LG-2 et les trois communautés côtières d'Eastmain, Nouveau Comptoir et Fort Rupert (les trois zones à l'étude totalisant une superficie de 2 000 km^2);

(2) Le choix d'un corridor routier entre les centrales LG-2 et GB-1 (une zone d'étude de 19 000 km^2);

(3) Le choix d'un corridor routier et d'une voie ferrée desservant un nouvel emplacement minier dans la région de Matagami (une zone d'étude de 21 000 km^2).

La marche à suivre habituelle utilisée dans ce genre d'étude consiste, tout d'abord, à effectuer une analyse préliminaire du corridor en se basant sur les facteurs techniques et économiques, pour en arriver à établir un nombre limité d'options. Ensuite, on choisit un corridor en fonction de critères environnementaux, à partir d'une l'analyse des différentes options et en sélectionnant le tracé qui présente les caractéristiques optimales. On tient compte des données écologiques dans les deux étapes de l'étude.

Les unités délimitées au niveau du système écologique constituent les cellules de base à partir desquelles toutes les informations enregistrées et analysées permettent de tracer le meilleur corridor possible, en suivant l'agglomération linéaire des systèmes écologiques qui présentent le plus de caractéristiques souhaitables et le moins d'éléments défavorables.

Les données de base et les clés d'interprétation suivantes entrent généralement dans le processus d'évaluation:

(1) le relief;
(2) les dépôts superficiels;
(3) l'abondance des cours d'eau;
(4) les terres humides ("wetlands");
(5) les types de terrain pour l'ingénierie;
(6) les risques de chablis;
(7) les risques d'érosion;
(8) l'attrait du paysage;
(9) les divers potentiels pour la faune.

Études d'impact

Les études d'impact constituent également un champ d'application important pour les données tirées de l'inventaire écologique. A divers égards, on y retrouve des aspects déjà traités plus haut et l'on n'ajoutera ici que quelques remarques supplémentaires.

Sur le territoire de la Baie James, tous les nouveaux projets font actuellement l'objet d'études d'impact comme la loi l'exige. La contribution des données écologiques à ces études d'impact varie considérablement selon la dimension du projet proposé, son emplacement, les éléments du milieu qui seront

probablement modifiés par le projet et l'existence d'autres types de renseignements.

Le plus grand projet qui fait actuellement l'objet d'une évaluation d'impact porte sur l'exploitation hydroélectrique des rivières Nottaway, Broadback et Rupert (projet NBR). L'ensemble des bassins hydrographiques de ces trois rivières, dont deux seront partiellement dérivées vers la troisième, représente une superficie totale de 123 000 km^2. A l'heure actuelle, divers groupes travaillent sur les aspects sectoriels du projet. Les résultats de leurs études seront ensuite analysés et feront l'objet d'un document de synthèse mettant en relief les aspects négatifs et positifs du projet.

L'état actuel des ressources naturelles et les utilisations traditionnelles du territoire par les autochtones constituent les plus importants aspects de l'énoncé des incidences. Même si ce renseignement n'est pas fourni dans l'inventaire écologique, les données écologiques ont servi à d'autres fins. Par exemple, on a tout d'abord consulté les cartes et les descriptions écologiques existantes pour obtenir une vue générale de la région. On a également utilisé des clés d'interprétation qui portaient surtout sur la faune.

L'importance de l'utilisation des données dépendra essentiellement du caractère fiable de ces clés et de leur capacité à refléter une situation réelle. Cependant, elles ne seront pas utilisées sans discernement mais feront l'objet d'essais sur de petites super ficies avant d'être appliquées à une plus grande échelle. La SDBJ a déjà fourni au chef du projet NBR et à la SEBJ une liste informatisée qui énumère les diverses capacités requises pour chaque système écologique de la zone du projet. Un groupe élabore actuellement pour cette région, un système de cartographie informatisé, outil indispensable dans le cas de superficies si étendues et d'unités si nombreuses.

Il est donc trop tôt pour établir le degré d'utilisation des données dans l'étude d'impact du projet NBR. On achève actuellement la réalisation d'un outil capable de permettre une utilisation intensive, mais toute la question repose maintenant sur la valeur des clés d'interprétation. Nombre d'autres études d'impact, moins importantes, sont fondées sur les données, certaines de façon presque exclusive. C'est le cas de l'aménagement de la rivière Desaulniers, de la route entre LG-4 et Caniapiscau et de la dérivation de la rivière Laforge. Pour les travaux relatifs à de petites superficies, tels que petites digues ou terrains de camping, les données de l'inventaire sont peu utilisables parce qu'elles sont incompatibles avec l'échelle de présentation nécessaire.

Aménagement du territoire

L'aménagement du territoire pour des activités autres que la production hydroélectrique n'en est qu'au stade initial dans la région de la Baie James. On prépare actuellement un plan d'aménagement général mais, son objectif étant d'établir l'orientation générale des futurs aménagements, il ne fera que très peu appel aux données.

A ce niveau de planification, le type de renseignements produits par l'inventaire écologique doit céder la place à d'autres considérations comme l'état actuel des ressources naturelles, les utilisations traditionnelles des terres, les affectations de certaines parties du territoire découlant de l'accord conclu entre les autochtones et les gouvernements fédéral et provincial, les limites imposées par les projets hydroélectriques, ainsi que les facteurs sociaux et économiques.

Les données écologiques joueront un rôle plus important dans la préparation d'une version plus détaillée du plan. Elles contribueront également beaucoup à l'élaboration de plans régionaux d'utilisation des terres à plus petite échelle. Parmi les autres projets d'aménagement qui ont fait appel aux renseignements de l'inventaire écologique, les suivants servent d'exemples types:

(1) L'identification d'emplacements convenables pour l'établissement d'une petite ville (5 000 habitants);

(2) Une étude destinée à établir le rôle à long terme de la ville de Radisson;

(3) L'évaluation des possibilités de la région du lac Wescapis en tant que réserve de chasse et pêche et de zone réservée aux loisirs de plein air.

Gestion des ressources

L'emploi de l'inventaire écologique dans le domaine de la gestion des ressources ne fait que commencer et, à ce jour, seuls quelques travaux, qui portaient tous sur la gestion de la faune, ont fait appel aux données. Le rapport entre les diverses espèces de faune

et les régions écologiques a été établi et les connaissances ainsi acquises serviront à évaluer et à surveiller les populations.

Au niveau du type écologique, on a déterminé un autre ensemble de rapports entre la population actuelle et les habitats grâce à des cartes utilisées à ce niveau de perception. Combiné aux diverses clés d'interprétation du potentiel pour la faune, ce genre de renseignement permettra de déterminer dans quelle mesure il serait possible d'établir des services de pourvoyeur sur le territoire, et à cette fin de répondre à des questions d'ordre très pratique, comme le nombre de territoires, leur taille, leur emplacement et leurs limites.

Les données de l'inventaire écologiques ont servi à réaliser deux autres études portant sur le potentiel pour le castor. La première visait à déterminer avec exactitude l'importance des populations de castor se trouvant à l'emplacement du futur réservoir LG-2, renseignement devant être utilisé dans la préparation d'une vaste opération de piégeage avant qu'on ne procède à l'inondation de la région.

Dans le cadre de la seconde étude, on envisageait la possibilité de transporter les populations de castor du futur emplacement du réservoir Opinaca à d'autres secteurs de la réserve Eastmain, qui présente un potentiel élevé mais dont la population a été surexploitée.

Descriptions environnementales

Les données de l'inventaire écologique et diverses clés d'interprétation sont des sources d'information très utilisées dans la préparation de descriptions générales de certains milieux, certaines régions ou certains secteurs d'exploitation des ressources.

On les utilise notamment de la façon suivante:

(1) Description de la région Amos-Matagami, l'objectif visé étant de faire la synthèse de tous les renseignements sur le territoire et sur les ressources naturelles de la région, ce qui constituerait la première étape de la préparation d'un plan régional d'utilisation des terres.

(2) Inventaire de la région LG-3 - LG-4, qui suppose la collecte de toutes les données sur les ressources naturelles, y compris la condition actuelle et le potentiel des écosystèmes, qui serviront de base à une évaluation environnementale des incidences.

(3) Description biophysique du secteur du lac Mistassini, qu'affectera le projet d'exploitation hydroélectrique du complexe des rivières Nottaway, Broadback et Rupert.

Dans ce dernier cas, on s'est servi des renseignements suivants:

1) Cartes et descriptions au niveau du système écologique, servant de point de départ à la préparation d'une carte détaillée des dépôts superficiels;

2) Notes concernant la végétation prises sur le terrain, servant à la préparation d'une classification du type écologique; les notes concernant l'épaisseur de l'humus servent ensuite à préparer une carte de l'épaisseur de l'humus;

3) Clé du potentiel pour le castor.

On a toutefois préféré les données concernant les populations réelles d'orignal, de caribou et de diverses espèces de poissons aux renseignements concernant le potentiel, lesquels étaient jugés insuffisants.

Information de base pour les études de ressource

Puisque l'inventaire écologique est le seul inventaire qui porte sur tout le territoire, on en utilise souvent les résultats dans la préparation de tout nouveau projet. Le genre de renseignements dont ont besoin les utilisateurs comprend, entre autres, les données au niveau du système écologique ainsi que les notes prises sur le terrain.

Les deux activités mentionnées ci-après donnent un aperçu des applications des données:

(a) Le repérage des dépôts de tourbe qui flotteront probablement une fois que les réservoirs LG-2, Opinaca et Caniapiscau seront remplis. Données utilisées: classification des types écologiques des milieux organiques, notes prises sur le terrain.

(b) La classification des lacs dans le but d'évaluer les taux de productivité. Données utilisées: dépôts superficiels; matériaux du rivage; pente du rivage; abondance des cours d'eau et des terres humides.

Dans ce type d'application, l'usager a besoin d'informations très précises qu'il utilisera avec d'autres données provenant elles-mêmes d'un programme conçu de manière à satisfaire à des besoins particuliers. Les types

écologiques considérés comme unités taxonomiques, les notes prises sur le terrain et la cartographie préliminaire morpho-sédimentologique sont très souvent utilisés.

Les connaissances de première main qu'acquièrent les personnes qui se rendent sur le terrain, les gens du "Service des études écologiques régionales", permettent souvent de fournir un premier aperçu de la région ou d'éclaircir certains aspects particuliers.

Divers

Un dernier projet met un terme à cet examen schématique des applications de l'inventaire écologique du territoire de la Baie James. Il concerne les études archéologiques réalisées le long des rivières La Grande et Kanaaupscow.

Alors qu'on tentait de localiser les emplacements où il faudrait faire des fouilles archéologiques, on a cherché à établir une corrélation entre les régions présentant un potentiel élevé pour la faune et la présence de campements d'autochtones. On a dressé des cartes du potentiel des terres pour le castor, le lièvre et le lagopède des saules et on a découvert que les régions présentant le potentiel combiné le plus élevé pour ces espèces correspondaient dans une certaine mesure aux régions les plus fréquemment utilisées comme lieu de campement. Ces résultats n'en sont pour le moment qu'au stade préliminaire mais ils montrent que la perspective adoptée n'est pas dépourvue de valeur.

PROBLÈMES QUE POSE L'UTILISATION DES DONNÉES

Dans la première partie du présent document, nous avons décrit la manière dont on utilise les données. Cela ne reflète toutefois qu'un seul aspect, car les projets réalisés dans le territoire ne font pas tous appel à l'inventaire. Pour diverses raisons, que nous tenterons de résumer, certains usagers potentiels n'ont pas été en mesure d'utiliser les données.

On peut en déterminer cinq raisons principales:

1) les renseignements n'étaient pas disponibles au moment où on en avait besoin;

2) on ne savait pas dans quelle mesure les clés pour l'interprétation étaient valides;

3) les données étaient présentées à un niveau de perception qui ne correspondait pas aux besoins de l'usager;

4) le manque d'information, au niveau du système écologique, sur des éléments clés de l'environnement comme les habitats aquatiques, les rives et la végétation actuelle;

5) les usagers n'avaient pas l'expérience nécessaire pour exploiter les renseignements.

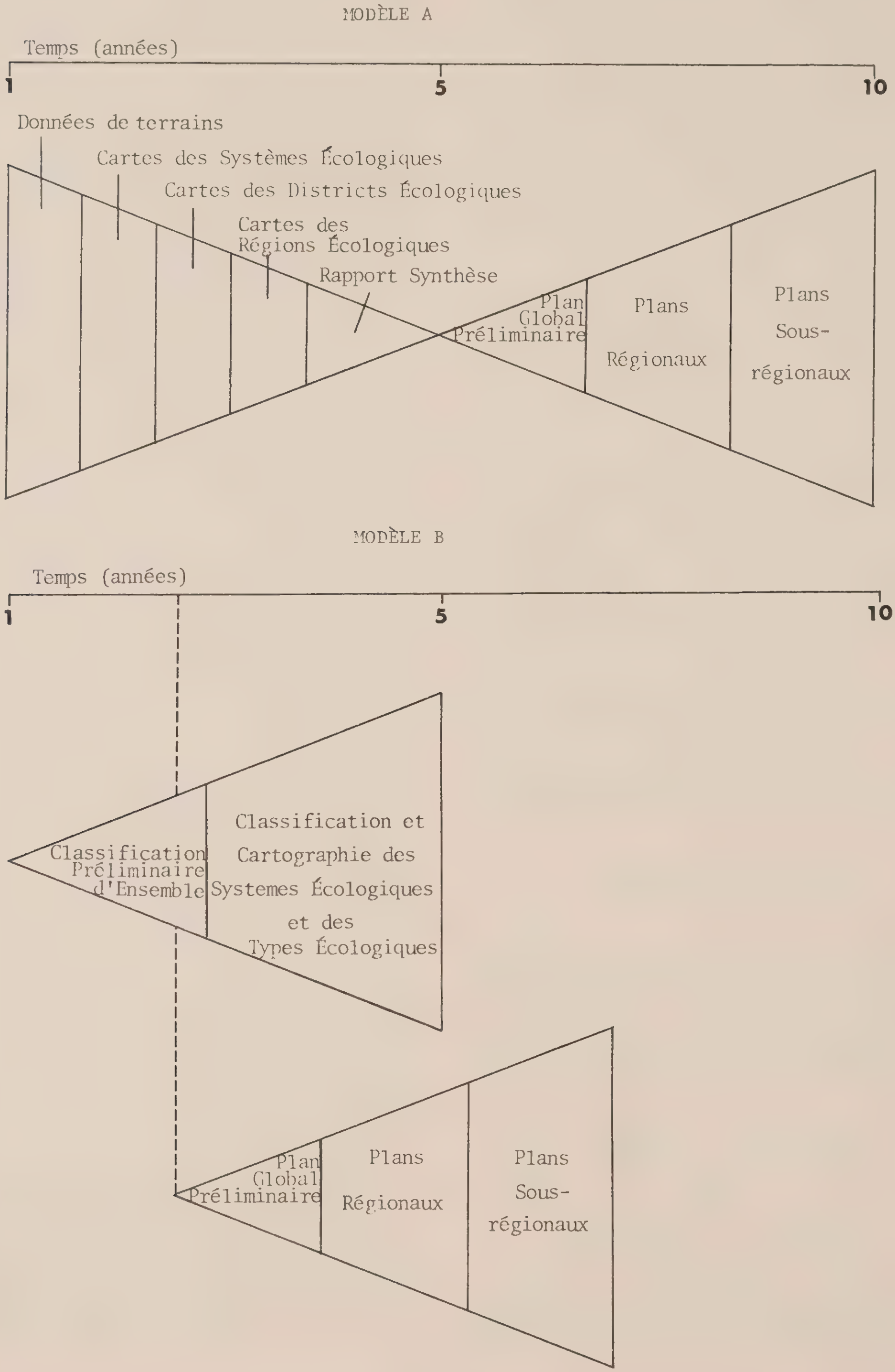
L'inventaire écologique a été entrepris au début de juin 1973, après le début des travaux de construction du complexe hydroélectrique de la rivière La Grande. De 1974 jusqu'au début de 1977, on a graduellement communiqué à la Société de développement de la Baie James les résultats de l'inventaire, sous la forme de cartes des systèmes écologiques à l'échelle 1:125 000 et de feuilles manuscrites de descriptions. La mise en ordinateur de cette masse de renseignements a commencé en 1974 et la banque de données est devenue exploitable à la fin de 1977. Parallèlement, on mettait au point les clés d'interprétation, lesquelles sont encore en cours de perfectionnement aujourd'hui, et l'on prévoit que les rapports de synthèses seront prêts au cours de la présente année.

L'ordre dans lequel les renseignements sont devenus disponibles et exploitables a considérablement influé sur leur utilisation, ou leur non-utilisation, dans le cas de nombreux projets. Nous traitons de l'emploi d'un outil qui est toujours en cours de fabrication. Cette situation explique en grande partie pourquoi l'inventaire écologique n'a pas joué le rôle qui lui revenait dans la préparation de la première phase du plan d'aménagement de la région et dans l'évaluation environnementale du projet d'exploitation hydroélectrique du complexe des rivières Nottaway, Broadback et Rupert.

Le graphique suivant établit une comparaison, en fonction du temps hypothétique, entre la disponibilité de l'information écologique à divers niveaux de perception et la séquence des besoins pour ces informations-mêmes dans un processus d'ensemble de planification du territoire.

La figure 1 représente deux situations modèles où l'information écologique est disponible au niveau de perception requis à chaque étape dans le processus d'ensemble de planification du territoire. Ce qui est essentiel dans ces deux situations modèles, c'est le fait que des rapports et une étude d'ensemble

Figure 1: Deux Situations Modèles pour l'Inventaire et la Planification Écologique



ou synthèse globale de l'information sont disponibles dès les premières étapes du processus de planification, c'est-à-dire la préparation d'un plan d'ensemble conceptuel préliminaire. A ce niveau général de planification, seule une information écologique hautement synthétisée est utilisable.

Les modèles A et B diffèrent dans l'approche de l'inventaire écologique. Le modèle A est l'illustration d'une situation dans laquelle les études procèdent à partir d'un relevé détaillé et s'orientent vers une synthèse de l'ensemble. Par contre, le modèle B commence par une étude d'ensemble et procède par la suite vers l'inventaire et une classification plus détaillée. Le modèle A évoque une situation idéalisée de la Baie James et le modèle B se rapproche du processus commencé au Labrador.

La figure 2 représente la situation actuelle dans le territoire de la Baie James. L'inventaire écologique du territoire met, au départ, l'accent sur la définition des systèmes écologiques et des types écologiques au moyen de relevés de terrain détaillés. Ce n'est que par la suite, qu'on définit les régions écologiques. La définition des districts écologiques et la production des rapports synthèses, sont les étapes finales du programme quinquennal.

Le problème de l'exploitation des données est lié à leur disponibilité. L'ensemble du territoire est divisé en 40 000 unités écologiques au niveau du système écologique, chacune étant définie par les caractéristiques générales des habitats terrestres et aquatiques et comportant une énumération des types écologiques qui forment les configurations. Pour le moment, l'ordinateur de la Société de développement de la Baie James ne peut produire que des listes de caractéristiques, individuelles ou combinées. Leur mise sur carte doit encore être faite à la main. Cela constitue un grand problème pour l'usager qui doit étudier une vaste région. Pour le surmonter, la Société de développement de la Baie James est en train de mettre au point des dispositifs qui permettront de cartographier électroniquement les données.

Le deuxième grand problème auquel se heurte l'utilisateur est la validité des clés d'interprétation. A ce sujet, les diverses réactions vont de la grande confiance au rejet pur et simple. Toutefois, les usagers ont tous en commun la conviction que beaucoup de clés d'interprétation doivent être mises à l'épreuve sur le terrain avant que leur utilisation ne se généralise. Le processus en question a déjà commencé et déjà on commence à mieux savoir dans quelle mesure une clé particulière reflète la réalité. Ainsi, on comprend maintenant mieux les applications et les limitations potentielles des clés.

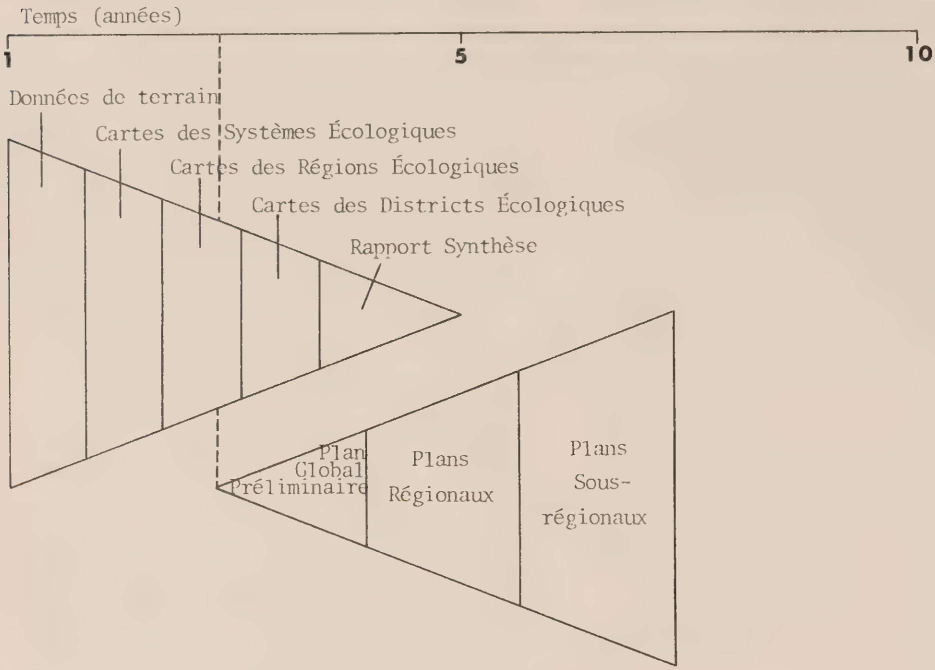
L'inventaire écologique du territoire de la Baie James est principalement axé sur la collecte et la présentation de données biophysiques au niveau du système écologique, cartographiées à l'échelle de 1:125 000. Bien que les types écologiques aient été classifiés, on n'a pas établi de cartes à ce niveau de perception. On a achevé la préparation d'une carte des régions écologiques en 1976, mais la description des districts écologiques n'est pas encore prête. Jusqu'ici, les données présentées au niveau de la région écologique n'ont guère eu d'autre utilisation que dans la planification d'une enquête aérienne sur la faune. Elles ont également servi de cadre à un rajustement au niveau régional de certaines clés d'interprétation.

Si l'on en juge d'après les discussions que nous avons eues avec les usagers potentiels, lesquels considèrent que les données présentées au niveau du système écologique sont trop détaillées, il semble que le cadre du district écologique aurait mieux convenu à certains de leurs besoins. On conçoit que, lorsqu'on cherche à se représenter les caractéristiques régionales d'un territoire qui couvre plus de 410 000 km^2, le niveau du système écologique puisse être trop détaillé et qu'il défie la capacité de synthèse de l'esprit de l'homme.

La plupart des usagers déplorent l'absence de données intégrées concernant le couvert végétal actuel, composante essentielle de l'environnement; il s'agit là, dans de nombreux cas, des renseignements indispensables lorsque les gestionnaires doivent prendre des décisions.

Les usagers estiment en général que la classification des habitats aquatiques, des cours d'eau et des "wetlands" n'a pas reçu toute l'attention qu'elle mérite. Là encore, il s'agit d'éléments essentiels du paysage et leur description est sans doute aussi importante que celle de la partie terrestre du territoire. Il est particulièrement important de noter que ces habitats abritent de nombreuses espèces de faune pour lesquelles on a cherché à mettre au point des clés de potentiel. Les faibles résultats obtenus avec certaines clés sont directement attribuables au manque d'information sur ces habitats. Pour plusieurs usagers, il est quelque peu présomptueux de qualifier

Figure 2: La Situation Actuelle pour la Planification dans le Territoire de la Baie James



d'écologie un inventaire qui accorde si peu de place à la description des habitats aquatiques et où il n'est même pas question du couvert végétal actuel.

De plus, la rareté des données concernant les habitats des rives, dont la présence influe sur la répartition de nombreuses espèces de faune, est aux yeux de beaucoup, un problème. Si la plupart des habitats des rives sont identifiés au niveau du type écologique du territoire, ils sont souvent négligés au niveau du système écologique puisqu'ils ne sont identifiés que rarement à ce niveau de perception.

Il faut ajouter que les problèmes d'utilisation des données ne trouvent pas tous leurs origines dans l'inventaire lui-même. Bien souvent, ce sont les usagers qui n'ont pas la préparation nécessaire pour exploiter les renseignements. Il est particulièrement important de noter que de nombreux utilisateurs considèrent que le résultat même du projet, c'est la cartographie du système écologique et qu'ils ignorent à peu près tout des autres aspects de l'inventaire.

Afin de corriger ces lacunes, le Services des études écologiques régionales, responsable de l'inventaire, a multiplié les contacts entre spécialistes en inventaire et usagers potentiels, grâce à des ateliers qui simulaient des séances de travail. Cette démarche s'avère très utile mais elle n'a atteint qu'un nombre limité d'utilisateurs.

CONCLUSIONS

Il ne fait aucun doute que les renseignements fournis par l'inventaire ont été utiles pour la réalisation de toute une gamme de travaux, allant de l'archéologie aux descriptions environnementales et à l'évaluation du potentiel des terres pour la production de diverses ressources naturelles renouvelables. Jusqu'ici, ils ont principalement servi à la réalisation d'études des emplacements des corridors, d'études d'impact sur le milieu et d'autres études réalisées au niveau régional.

L'inventaire écologique constitue un instrument qui s'est révélé très utile et qui peut

grandement faciliter les décisions que nous devons prendre en ce qui concerne l'exploitation et la conservation des ressources. Toutefois, il ne s'agit pas là du seul genre de renseignements dont nous ayons besoin, et elle ne peut se substituer à certains inventaires de type classique, où l'on trouve des informations concernant l'état actuel des ressources naturelles telle que la forêt et diverses espèces de faune, pour ne mentionner que celles-là.

Il est encore trop tôt, pour tirer des conclusions définitives quant à l'utilité d'un instrument dont la mise au point n'est pas terminée. Dans bien des cas, on aurait pu utiliser les données pour la réalisation de travaux achevés ou en cours, mais on ne l'a pas fait tout simplement parce que les données n'étaient pas disponibles au moment où l'étude a été entreprise. Dans les années à venir, nous serons à même de déterminer la valeur réelle de l'instrument.

L'étendue des applications futures dépendra aussi largement de la connaisance pratique qu'auront les usagers potentiels de la classification elle-même, ainsi que de ses résultats et interprétations possibles. Bien qu'on ait déjà consacré beaucoup de temps à expliquer aux usagers potentiels comment se servir des données, il semble de la plus haute importance d'organiser d'autres ateliers sur les applications et d'y inviter les usagers potentiels.

Il y aura également lieu d'accorder plus d'attention à la mise au point des clés d'interprétation. Celles-ci marquent souvent le point de rencontre entre les spécialistes de l'inventaire et les usagers et la confiance que ces derniers peuvent mettre dans l'interprétation déterminera l'ampleur de l'utilisation des données écologiques.

Dans la présentation, nous avons cherché à donner une appréciation de l'inventaire écologique du territoire de la Baie James en la fondant sur les utilisations actuelles. Nous estimons dans l'ensemble que l'inventaire écologique est très utile et qu'il continuera de l'être et, si c'était à refaire, nous n'hésiterions pas à en encourager la réalisation. Le fait que l'Hydro-Québec soit sur le point de s'entendre avec d'autes organismes pour la réalisation d'un inventaire du même genre sur une grande partie du territoire de la Côte nord du Saint-Laurent est particulièrement révélateur et atteste la valeur que reconnaissent les responsables des décisions à cet instrument de gestion.

REMERCIEMENT

L'enquête auprès des utilisateurs sur laquelle la présente communication est fondée a été effectuée par Le Groupe Dryade Ltée pour le compte d'Environnement Canada.

BIBLIOGRAPHIE

Bergeron, R., J.M. Levasseur, J.M. Bélanger et J. Gingras. 1976 - Évaluation du potentiel faunique du territoire de la Baie James. Compte Rendu. Symposium Environnement Baie James. Environnement Canada, SDBJ et SEBJ, pp. 647-676.

Jurdant, M., J.L. Bélair, V. Gérardin et J.P. Ducruc. 1977 - L'inventaire du Capital Nature. Direction régionale des terres, Environnement Canada, Québec, 202 p.

Sous-comité sur la classification biophysique des terres. 1969. Guidelines for Biophysical Land Classification. (compilé et édité par D.S. Lacate). Service canadien de la foresterie. Publication No. 1264, Ottawa, 61 p.

STRUCTURING OF LAND SYSTEMS WITH THE AID OF THE SYSTEM 2000*

P. Gimbarzevsky
Forest Management Institute
Canadian Forestry Service
Ottawa, Ontario

ABSTRACT

Computer assisted structuring of land systems has been found to be a highly useful approach to manipulation of ecological inventory data. Use of the System 2000 (S2K) permitted definition of simple, compound and complex land systems in a study of 2036 land units with field information comprising geomorphic origin, soils, drainage conditions, bedrock, aspect, elevation and topography for the 5000 km² area of Nahanni National Park, Yukon Territory. (Ed. Abstr.)

RÉSUMÉ

La délimitation des systèmes écologiques à l'aide d'un ordinateur s'est montrée très utile pour manipuler les données d'inventaire écologique. Le Système 2000 (S2K) a servi à définir les systèmes écologiques simples, mixtes et complexes, au cours d'une étude de 2036 unités écologiques, à l'aide de renseignements, pris sur le terrain, concernant l'origine géomorphologique, les sols, les conditions de drainage, la roche de fond, le paysage, l'altitude et le relief d'une région de 5000 km² du parc national Nahanni, au Yukon. (Rés. Éd.)

INTRODUCTION

An integrated approach to environment inventory was applied by the Forest Management Institute (FMI) in a recent survey of some 500 km² wilderness area in Nahanni National Park. The purpose of this study, in addition to providing factual information on the land, vegetation and water resources for immediate use by parks managers and planners, was to carry out development work on the application of remote sensing technology for the acquisition and presentation of resource information.

Due to the relatively large size of the study area extending for about 450 km along two major rivers (South Nahanni and Flat), its remote location, and lack of access, the survey was conducted at a land system level. Land units with similar characteristics were delineated on medium scale aerial photographs as patterns of landforms and presented on 1:50,000 scale base maps. The work involved air photo analysis of landscape patterns, stratification of the land surface into discrete map units and grouping of these units into 48 distinct land systems with the aid of a computer program known as the System 2000 (S2K).

AIR PHOTO ANALYSIS

A systematic analysis of conventional black and white aerial photographs, taken in 1962 at a scale of 1:50,000, was used for delineation of landscape units exhibiting similar characteristics. An attempt was made to stratify the entire 5000 km² area into map units, as homogeneously as possible at that scale, in regard to geomorphic origin, texture, depth to bedrock and drainage conditions of surficial material, as well as topographic features, elevation and aspect. Basic data for each map unit were recorded on a land system description sheet, where each unit was referenced by a consecutive number and air photo identificatio (roll, line and photo number). After the field verification and analysis of collected ground information, the preliminary land units delineated on aerial photographs were revised or corrected where necessary and transferred to a 1:50,000 scale base.

A revised listing of the resulting 2036 map units was compiled and manually sorted into ten groups of dominant geomorphic origin: till, glaciofluvial, lacustrine, lacustrine-colluvial, colluvial, waterlaid, aeolian, organic, rock and snow/ice fields.

USE OF THE SYSTEM 2000 (S2K)

The *System 2000* is a general purpose data base management system that operates on IBM 360/370, Amdahl 470, Univac 1100, CDC 6000, CYBER 70 and CYBER 170 series computers. For the Nahanni study, FMI has been using the Marine Sciences UNIVAC 1106 installation at Pat Bay, B.C. connected to the FMI office by C.T.A. telephone services and a 300 Bank Decwriter II terminal.

After completion of a series of computer test runs, programmed for the reduction of land data, the System 2000 was adapted to sort the aspect, topography, and 10% classes of drainage and

* This paper was not prepared in time for circulation at the Victoria meeting.

texture by discriminating levels of material origin. When the original test runs indicated that the soil texture was almost always referenced directly to the origin of the material, it was dropped from the land system description, but retained on the sorting files.

In order to load essential information into the data base system, a definition was created for each column of data designated for sorting purposes in code form consistin of a capital letter and numerials, (e.g. C29 - till, C43 - organic, C6 - drainage class 1, C600 - steep variable topography, etc.).

There are potentially 3,758,000 variables to be sorted into a potential 28,800 groups which could occur and for which provision must be made in the data base. Some of these potential groups may be combined manually after seeking the range of the individual components and checking these components on aerial photographs.

SORTING PROCEDURES

The structuring of land systems commenced with the sorting of land units previously listed manually and divided into ten geomorphic origin groups. On the basis of a degree of dominance of a single geomorphic material the land units were sorted into three general levels:

Level 1 - where a single material comprises 80% or more,

Level 2 - where a single material is less than 80%, but more than 50%, and

Level 3 - where a single material comprises less than 50% of the map unit.

The land units within each of the three levels were subjected to a further computer and manual soring by topography, aspect and drainage.

The 2036 map units were placed, according to their relief features, into one of the following five dominant classes:

Steep Variable topography - includes ridges, high hills, multiple peaks, highly dissected terrain with steep-sided valleys;

Moderate variable topography - includes knolls, rolling plateaux or undulating uplands, valleys and depressions;

Flat or minor variable topography - includes elevated plateaux, depressed flats and plains with or without eroded channels;

Steep constant slopes - includes cliffs, simple or complex slopes with more than 31% incline;

Moderate constant slopes - simple and complex slopes up to 30% incline.

Following a computer grouping by the dominant aspect (N, S, E, W, NO, SO, EO, WO and F), the land units were manually sorted by drainage conditions and placed into one of the following six drainage classes:

1.	Rapidly drainged	(Excessive dry)
2.	Well drained	(Dry)
3.	Moderately well drained	(Fresh)
4.	Imperfectly drained	(Imperfect)
5.	Poorly drained	(Poor)
6.	Very poorly drained	(Very poor)

RESULTS

From the final manual sort a total of 48 distinct land systems were defined and described as subdivisions of dominant geomorphic origin groups.

Till Land Systems (T)
Area: 305.2 km^2 (6.3% of the Park)
Number of map units: 128

These generally occur on steep to moderate variable topography and steep slopes, with drainage classes ranging from well to imperfectly drained. Soils are usually stoney with a silty sand matrix on predominantly south and east aspects.

5 subdivisions (T_1 to T_5):

T1 - well drained on steep constant slopes and steep variable topography
T2 - moderately well to imperfectly drained on steep constant slopes and steep variable topography
T3 - moderately well to imperfectly drained on moderate slopes and topography
T4 - imperfectly to moderately well drained on moderate slopes and topography
T5 - moderately well to imperfectly drained on flat to moderate topography

Glaciofluvial Land Systems (F)
Area: 74.48 km^2 (1.54% of the Park)
Number of map units: 40

These are observed on moderate topography with variable drainage. Soils are well sorted and are usually coarse textured sand and stoney. These system are well differentiated and commonly occur on southern, eastern and flat aspects.

4 subdivisions (F_1 to F_4):

F1 - well to moderately well drained on moderate to flat topography
F2 - moderately well to well drained on moderate topography
F3 - moderately well to imperfectly drained on moderate slopes and topography
F4 - variable drainage on moderate to flat topography

Lacustrine and Land Systems (L)
Area: 89.5 km^2 (1.85% of the Park)
Number of map units: 34

Lacustrine land systems occur on moderate and steep variable topography and all aspects. Drainage ranges from well to imperfect on these deposits where silty clay dominates. There is little variation in soil structure or composition to the depth of 50 to 100 m.

3 subdivisions (L_1 to L_3):

L1 - moderately well to well drained on steep and moderate variable topography
L2 - moderately well to imperfectly drained on steep variable topography and slopes
L3 - moderately well to poorly drained on moderate variable and flat topography

Colluvial Land System (C)
Area: 2396 km^2 (49.45% of the Park)
Number of map units: 927

Colluvial land systems are the most common in the study area. They include gravity deposits in the form of screes, landslides, etc. These sites are usually dry and drained. Topography is variable with no dominant aspect. Materials are generally coarse textured and can be from any other mode of deposition that has been relocated by gravity. An exception is solifluction of unstable organic soils on moderate slopes.

12 subdivisions (C_1 to C_{12}):

C1 - rapidly drained on steep slopes and topography
C2 - rapidly to well drained on steep slopes and topography
C3 - well drained on steep slopes and topography
C4 - moderately well to well drained on steep slopes and topography
C5 - moderately well drained on steep topography
C6 - well drained to imperfectly drained on steep topography and slopes
C7 - imperfectly to poorly drained on steep slopes and topography
C8 - moderately well to imperfectly drained on flat terrain
C9 - rapidly drained on moderate topography and flat terrain
C10 - rapidly to well drained on moderate topography and some flat terrain
C11 - well to moderately well drained on moderate topography and some flat terrain
C12 - moderately well to imperfectly drained on moderate topography and slopes

Lacustrine-Colluvial Land System (L/C)
Area: 194.58 km^2 (4% of the Park)
Number of map units: 90

These land systems are usually well differentiated and were established to depict lacustrine areas that are inherently unstable due to internal physical forces and gravity. Massive slumping and sheet erosion are typical of these sites.

6 subdivisions (L/C_1 to L/C_6):

L/C1 - rapidly drained on steep slopes
L/C2 - well drained on steep slopes and topography
L/C3 - moderately well drained on steep and moderate slopes and topography
L/C4 - moderately well to imperfectly drained on steep slopes and moderate slopes
L/C5 - imperfectly drained on moderate slopes
L/C6 - variable drainage (moderagely well to imperfect) on mainly flat terrain

Waterlaid Land System (W)
Area: 303.1 km^2 (6.28% of the Park)
Number of map units: 265

These are well differentiated land systems with variable textures and drainage classes; usually on gentle slopes or flat terrain.

6 subdivisions (W_1 to W_6):

W1 - rapidly to well drained on moderate to steep slopes
W2 - well to moderately well drained on moderate topography and flat terrain
W3 - moderately well to imperfectly drained on moderate slopes and flat terrain
W4 - rapidly to well drained on flat topography and gentle slopes
W5 - well, moderately well and imperfectly drained on flat terrain and moderate slopes
W6 - imperfectly to poorly drained on flat terrain and moderate slopes

Aeolian Land System (A)
Area: 0.25 km^2 (0.05% of the Park)
Number of map units: 1

Very coarse-textured wind deposits occur in very small pockets (unmappable) on Jackfish Mountain and Yohin Ridge. There is one type

mapped within the park.

A - rapidly drained slopes

Organic Land Systems (O)
Area: 525 km^2 (10.84% of the Park)
Number of map units: 212

These land systems are moderately well differentiated with textures generally fibric to mesic. Topography and slopes are usually moderate to flat, and drainage somewhat veriable. Solifluction often occurs on both steep and moderate slopes.

5 subdivisions (O_1 to O_5):

O1 - moderately well to imperfectly drained on steep slopes and moderate topography
O2 - imperfect drainage on moderate topography and steep slopes
O3 - imperfect to very poor drainage on moderate slopes and flat topography
O4 - moderately well to imperfectly drained on moderate and flat topography and slopes
O5 - imperfect to very poor drainage on flat and moderate topography

Rock Land Systems (R)
Area: 854.25 km^2 (17.64% of the Park)
Number of map units: 37

Rock land systems are the second most frequen observed. They may occur as solid or in several weathered forms. Topography is generally steep and is well differentiated. Drainage is usually at the drier end of the specturm.

5 subdivisions (R_1 to R_5):

R1 - rapidly drained on steep slopes and topography
R2 - well drained on steep topography and slopes
R3 - well to moderately well drained on steep topography and slopes
R4 - moderately well to imperfectly drained on steep slopes
R5 - rapidly to imperfectly drained on flat terrain

Snow and Ice Fields (S)
Area: 3.52 km^2 (0.0% of the Park)
Number of map units: 2

Snow and ice fields occur on steep bedrock valley slopes at high elevations.

DISCUSSION

The computer assisted structuring of land systems is particularly useful in systematic surveys of extensive areas, with a large number of map units. It allows a rapid verification of significant characteristics, simplifies the process of data reduction, and provides a reliable data base that may be manipulated to summarize some specific conditions or to include additional components.

The sorting is relatively simple. The grouping of geomorphic material, for example, into three levels of dominance, indicates a degree of homogeneity of delineated map units. It may be used for additional checking of some unusual conditions, overall consistency of mapping and for designation of land units into three broad categories: simple, compound and complex land systems.

From the total of 2036 map units (average size about 2.5 km^2) there are 701 units (34%) that may be described as *simple* land systems, where the single dominant material comprises 80% or more of the unit area. About one half (1007 map units) are *compound* (50% to 80% of dominant material), and the remaining 16%, or map units are *complex* land systems, composed of 328 two or more codominant materials.

It is interesting to note that the highest degree of uniformity occurs in land units of waterlaid origin (72% of simple and systems), followed by the glaciofluvial (40%) and bedrock land systems (36% of simple land systems). The most heterogeneous in composition are land systems associated with the lacustrine (47% of complex land systems), organic (29%) and till landforms (28% in the complex category).

ACKNOWLEDGEMENTS

Thanks are due to Mr. L. Johnson and Mr. H. Mucha, FMI Computing Unit, and Mr. P. Addison, Consultant, for their cooperation and valuable contribution to this study.

REFERENCES

Gimbarzevsky, P. 1978. Land classification as a base for integrated inventories of renewable resources.pp. 169-177 *in* Proc. Workshop: Integrated Inventories of Renewable Natural Resources, Tucson, Ariz. Jan. 1978.

MIR - Systems Corporation. System 2000, General Information Manual. Austin, Texas. 21 p.

ECOLOGICAL FOREST LAND EVALUATION IN SASKATCHEWAN

W. C. Harris and A. L. Kosowan
Forestry Branch
Department of Tourism and Renewable Resources
Prince Albert, Saskatchewan

ABSTRACT

A land evaluation system has been developed to provide information which will assist in developing forest management practices; because of this, the system mainly involves land which is considered productive for tree growth and is oriented specifically to the tree aspect of each ecosystem.

Initially a total of twenty-three ecosystems were described in terms of biotic and non-biotic factors including information on the productivity of the tree component of each ecosystem. Two physical factors, soil drainage and soil texture, were found to relate best to tree growth, within a similar regional climate eg Mixedwood Section (Rowe, 1972), and therefore form the base for the system.

Three separate maps are currently produced for each area. A forest inventory map presents information on the species, height and density of trees; an age map gives the age of stands of trees; and a site type map gives information on the soil drainage and soil texture. These maps when used in conjunction with each other provide the basis for ecological forest management practices, which will eventually replace short-term forest stand inventories with permanent land-based ecological forest units.

RÉSUMÉ

Un système d'évaluation des terres a été mis au point dans le but de recueillir des renseignements devant servir pour l'élaboration de méthodes d'aménagement des forêts; il s'intéresse surtout aux terres productives du point de vue de la croissance des arbres et plus particulièrement à la place des arbres dans chaque écosystème.

Vingt-trois écosystèmes ont d'abord été identifiés en termes de facteurs biotiques et non-biotiques, et notamment de productivité de l'élément arbres de chaque écosystème. Deux facteur physiques, le drainage et la texture du sol, qui seront révélés comme agissant le plus directement sur la croissance des arbres, dans une région au climat semblable comme la section de forêt mixte (Rowe, 1972) constituent les éléments de base du système.

Trois cartes sont produites pour chaque secteur. Une première carte d'inventaire donne des renseignements sur les expèces, la taille et la densité des arbres, une deuxième carte chronologique donne l'âge des peuplements, et une troisième carte topographique décrit le drainage et la texture du sol. Ces trois cartes utilisées ensemble fournissent la base pour les méthodes écologiques d'aménagement forestier, qui remplaceront un jour les inventaires à court terme des peuplements par des relevés écologiques de secteurs forestiers permanents. (Trad. Éd.)

INTRODUCTION

In Saskatchewan, over the past ten years, the need for an ecological base for managing our forests has become increasingly more apparent. Demand for more and various wood products has increased tremendously. Recreational land use is increasing and pressures from wildlife, fisheries and agriculture are encroaching on forest lands. The pressures placed on the land are increasing yearly, thus priorities must be set. In order to make sound decisions regarding the land, (be it: tree species to plant, type of silvicultural treatment, harvesting methods, type of wood products expected, or whether the land should be removed from forest production and placed under other land use), one must have knowledge of the ecosystem as a whole, both biotic and non-biotic factors. If the information is to be practically useful when compiled it must be in a useable form. Mapping presents the information in a readily accessible form. These maps, backed up by written data on each map unit, will hopefully provide the required information for decisions regarding Saskatchewan's forest lands.

Table 1: Common Forest Ecosystems in Saskatchewan

Forest Ecosystem	Drainage	Soil Texture	Rotation Age	Maturity Age	Yields (m^3/ha) At Rotation	Yields (m^3/ha) At Maturity
Pinus-Cladonia/Arctostaphylos	Very Rapid-Rapid	Coarse	80	100	65	90
Picea glauca-Agropyron/Arctostaphylos	Very Rapid-Rapid	Coarse	90	140	110	140
Populus-Rosa/Elymus	Very Rapid-Rapid	Coarse	80	100	100	140
Picea glauca/Populus-Corylus	Very Rapid-Rapid	Coarse	85	120	140	175
Pinus-Vaccinium vitis-idaea/Pleurozium	Well	Moderately Coarse	70	105	135	180
Picea glauca/Pleurozium	Well	Moderately Fine	75	140	225	280
Populus-Corylus	Well	Moderately Fine	70	85	185	210
Picea glauca/Populus-Cornus	Well	Moderately Fine	75	90	210	240
Pinus-Pleurozium/Lycopodium	Moderately Well	Moderately Fine	65	95	180	265
Picea glauca-Pleurozium	Moderately Well	Fine	65	125	315	455
Populus-Aralia/Linnaea	Moderately Well	Moderately Fine	60	80	225	315
Picea glauca/Populus-Cornus/Mitella	Moderately Well	Fine	65	110	285	330
Picea mariana-Pleurozium/Hylocomium	Moderately Well	Moderately Fine	95	125	140	150
Pinus/Picea mariana-Pleurozium	Imperfect	Moderately Fine	85	115	120	140
Picea glauca/Populus-Cornus/Rubus	Imperfect	Fine	75	95	195	210
Picea mariana-Pleurozium/Ptilium	Imperfect	Moderately Fine	90	115	200	220
Picea glauca-Equisetum	Poor	Moderately Fine	80	130	120	145
Picea mariana-Pleurozium/Hylocomium	Poor	Moderately Fine	120	150	110	120
Larix-Picea mariana-Ledum/Pleurozium	Poor	Moderately Fine	90	135	125	140
Picea mariana-Ledum/Carex	Very Poor	Organic	130	--a	90	--a
Picea mariana-Ledum/Sphagnum	Very Poor	Organic	135	--a	80	--a
Larix-Carex/Sphagnum	Very Poor	Organic	100	--a	80	--a
Larix-Carex	Very Poor	organic	130	--a	65	--a

a - Information not available

BACKGROUND

Since 1949, information has been accumulated from permanent sample plots located in various forest stands south of the Precambrian Shield. These permanent growth and yield plots were established primarily to obtain information on the productivity of the various tree species on particular sites (Kabzems and Kirby, 1956; Kirby, 1962; Kabzems, 1971; Benson, 1973). General understory vegetation and soil data also were recorded on these plots. Beginning in 1975, detailed information on the soils and vegetation were collected to supplement that information already obtained. The data were compiled and a descriptive report published in 1976, putting together existing information for twenty-three common forest ecosystems occurring in the mixedwood section of Saskatchewan (Kabzems, Kosowan and Harris, 1976).

Each ecosystem was given a name according to the tree species and the dominant understory vegetation (Table 1). The description for each of these ecosystems dealt not only with soils, vegetation and productivity of the trees, but delved into cutting practices and silvicultural treatments for each of the forest ecosystems. This report forms the base of the ecological land evaluation system presently being used to map forest ecosystems of the province.

STUDY AREA

To evaluate the usefulness and practicability of the type of the land evaluation system adopted, an area of approximately 2,000 ha was chose in central Saskatchewan which was close enough to facilitate extensive field checking, presently used by the forest industry, and which provided a variety of sites. The area chosen lies between 53°N and 54°N latitude and 104°W and 106°W longitude and corresponds to the area covered by one 1:250,000 scale map sheet on the national topographic system (73H Prince Albert). About one half of the total area involved is outside of the provincial forest boundary and thus excluded from the study.

A small study area was chosen for several reasons: 1) the program has just begun and undoubtedly changes will be made 2) field checking is considered a necessity and a small area lends itself to more intensive checking; and 3) an area which is currently being harvested presents a pilot study of the applicability of the information for the user without involving the entire harvesting operation.

FOREST LAND EVALUATION

The system is based on the assumption that soil drainage and soil texture are the two

Table 2: Soil Drainage Classes

Soil drainage was broken down into seven categories as described:

1. Very rapidly drained: Soils developed in coarse textured sands (0.5 to 2 mm in diameter) and gravels (greater than 2 mm in diameter), which are of glaciofluvial or fluvial-lacustrine origin. These soils are dry, and precipitation is absorbed almost immediately. Groundwater and/or runoff does not influence vegetation growth.
2. Rapidly drained: Soils developed in medium, fine or loamy sands which are generally of fluvial-lacustrine or aeolian origin. Coarse textured glacial tills also occur in this class. They may contain gravel lenses or be underlain by material of other glacial deposition. Precipitation is almost immediately absorbed; however, at a slightly lesser rate than the previous class. These soils occur in all topographic classes. Groundwater and/or runoff do not influence vegetation growth.
3. Well drained: Profile textures and modes of origin are highly variable; however, the most common deposition is glacial till which is of a moderately coarse to moderately fine texture. At least one horizon is present which has the ability to significantly restrict water penetration. These soils are moisture deficient for short periods of time, and although they may be found on all slope positions, their most common occurrence is from the middle slope to crest positions. Coarse textured profiles are usually located on lower slopes, such that ground water and/or runoff influences vegetation growth and thus differentiates it from the previous two classes.
4. Moderately well drained: This drainage class is charaterized by soils which contain excess soil moisture for short periods of time. Moderately coarse to moderately fine textured glacial till is the most frequent parent material for soils in this category. However glaciolacustrine, glaciofluvial, fluvial-lacustrine and recent deposits also occur. These soils usually occur from the middle to the top slope positions. Their characteristic differentiation from the well drained class is the presence of a few mottles which may occur throughout the profile.
5. Imperfectly drained: Excess moisture for moderately long periods of time is portrayed in the soil profile by abundant mottling and/or gleying. These soils also may be developed from diverse glacial and recent deposits. Usually, they are located in the lower slope and depressional positions. The soil may be influenced by fluctuating water table.
6. Poorly drained: These are soils which have developed under prolonged saturated or near saturated conditions. The mineral substratum which is gleyed and/or mottled is usually overlain by a shallow layer of peat which may be in various stages of decompositions. Taxonomically, these soils are usually classified within the Gleysolic Order. Generally, these soils are found on level to undulating topography or in depressional areas.
7. Very poorly drained: Organic or Gleysolic soils which are continually saturated represent the soils occurring in this class.

factors having the greatest influence upon tree growth. Seven soil drainage classes (Table 2) and four broad textural classes (Figure 1) are recognized. The texture of the soils is taken from the parent material rather than any overlaying surficial deposits that may occur.

There are a total of twenty-eight possible combinations of soil texture - drainage, and with fifteen recognized forest cover types in Saskatchewan, this means a total of 420 possible ecosystems. However, not all forest cover types are found over the entire range of soil texture and drainage combinations, nor do all soil drainage-texture combinations exist in the forested region of Saskatchewan.

With a descriptive base of twenty-three of the most common ecosystems as a guideline and a suitable study area defined, actual mapping of forest ecosystems began in 1977. A numerical coding system is used to indicate the drainage, texture, and dominant tree species (Figure 2). Interpretation of infrared black and white photography at a scale of 1:12,500 for tree species and soil drainage is being carried out. Soil texture information is obtained from unpublished maps provided by the Soil Science Department at the University of Saskatchewan in Saskatoon.

DISCUSSION

Land is the base on which the entire system

hinges. In order to obtain optimum yields, management of our forests must be based on an ecosystem concept of which land is an integral component. In order to effectively manage our forests, a broader understanding of the complexities of the forest ecosystem is a must.

The ecological land evaluation system for the forest lands of Saskatchewan is only a portion of the overall information being compiled to assist in formulating management plans for the forests. Forest land type maps, in combination with forest inventory maps (Figure 3), age class maps (Figure 4) and data on the predicted productivity of the land, enables one to make more accurate management assessments eg time of harvesting (season and for maximum productivity), methods of reforestation, and management techniques to be applied to a particular forest site to result in a selected final wood product.

At present three separate maps are produced for each area primarily because the land type maps and age class maps are a new series and additions and deletions can be expected. When details of the overall system are finalized, all three maps will be combined and all the information will be placed on one map.

ACKNOWLEDGEMENTS

The authors wish to express cordial thanks to Mr. W. S. Bailey, Director of Forestry, Mr. J. A. Benson, Supervisor, Inventory Section and Mr. A. Kabzems, Resource Management Consultant, for their interest and administrative assistance during this project

Grateful acknowledgment is extended to other members of Inventory Section and Forestry Branch for their support.

REFERENCES

Benson, J.A. 1973. Black Spruce in Sask. Technical Bulletin No. 7. Dept. of Tourism and Renewable Resources, Prince Albert, Sask. 68 p.

Kabzems, A. 1971. Growth and Yield of Well-Stocked Spruce in the Mixedwood Section in Saskatchewan. Technical Bulletin No. 5, Dept. of Natural Resources, Prince Albert, Sask. 75 p.

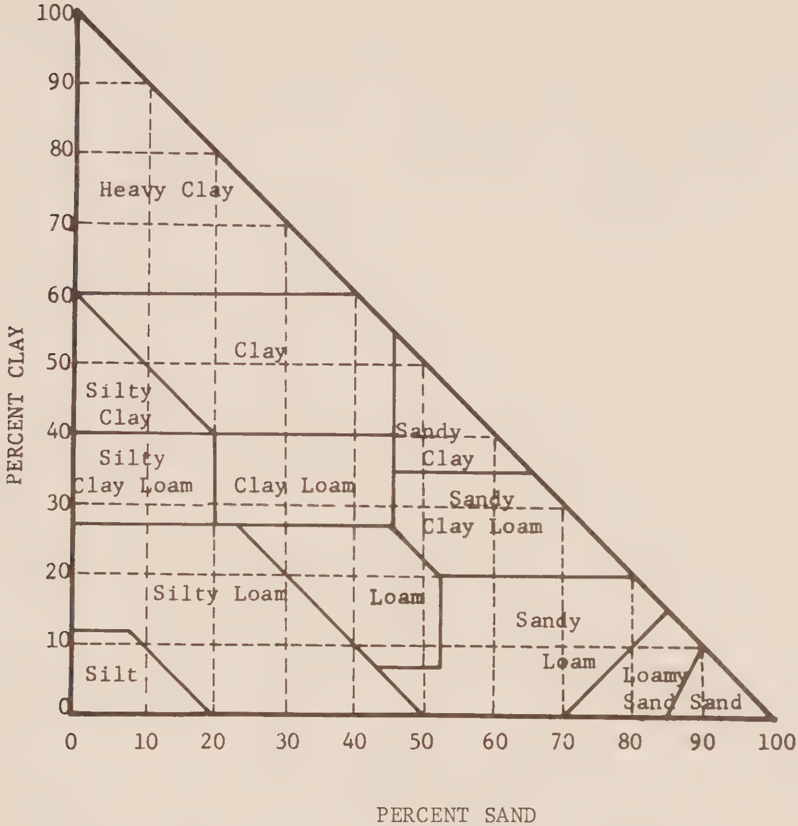
Kabzems, A. and C.L. Kirby. 1956. Growth and Yield of Jack Pine in Sask. Technical Bulletin No. 2, Sask. Dept. of Natural Resources, Prince Albert, Sask. 66 p.

Kabzems, A. & A.L. Kosowan and W. C. Harris 1976. Mixedwood Section in an Ecological Perspective, Sask. Technical Bulletin No. 8, Department of Tourism and Renewable Resources, Prince Albert, Saskatchewan. 118 p.

Kirby, C.L. 1962. Growth and Yield of White Spruce-Aspen Stands in Sask. Technical Bulletin No. 4, Dept. of Natural Resources, Prince Albert, Sask. 58 p.

Rowe, J. S. 1972. Forest Regions of Canada, Dept. of Environment, Canadian Forestry Service Publication No. 1300. Ottawa, Ontario. 172 p.

Figure 1: Textural triangle Percent sand and clay in common textural soil classes. The remaining percent is silt.*



Soil textures are broken down into four broad groups for this study:

Coarse:	Sand, loamy sand
Moderately coarse:	Sandy loam, loam, silt loam, silt
Moderately fine:	Sandy clay loam, clay loam, silty clay loam
Fine:	Sandy clay, clay, heavy clay, silty clay

* Taken from the Canada Soil Survey Committee.(1970). *The System of Soil Classification for Canada*, Agriculture Canada.

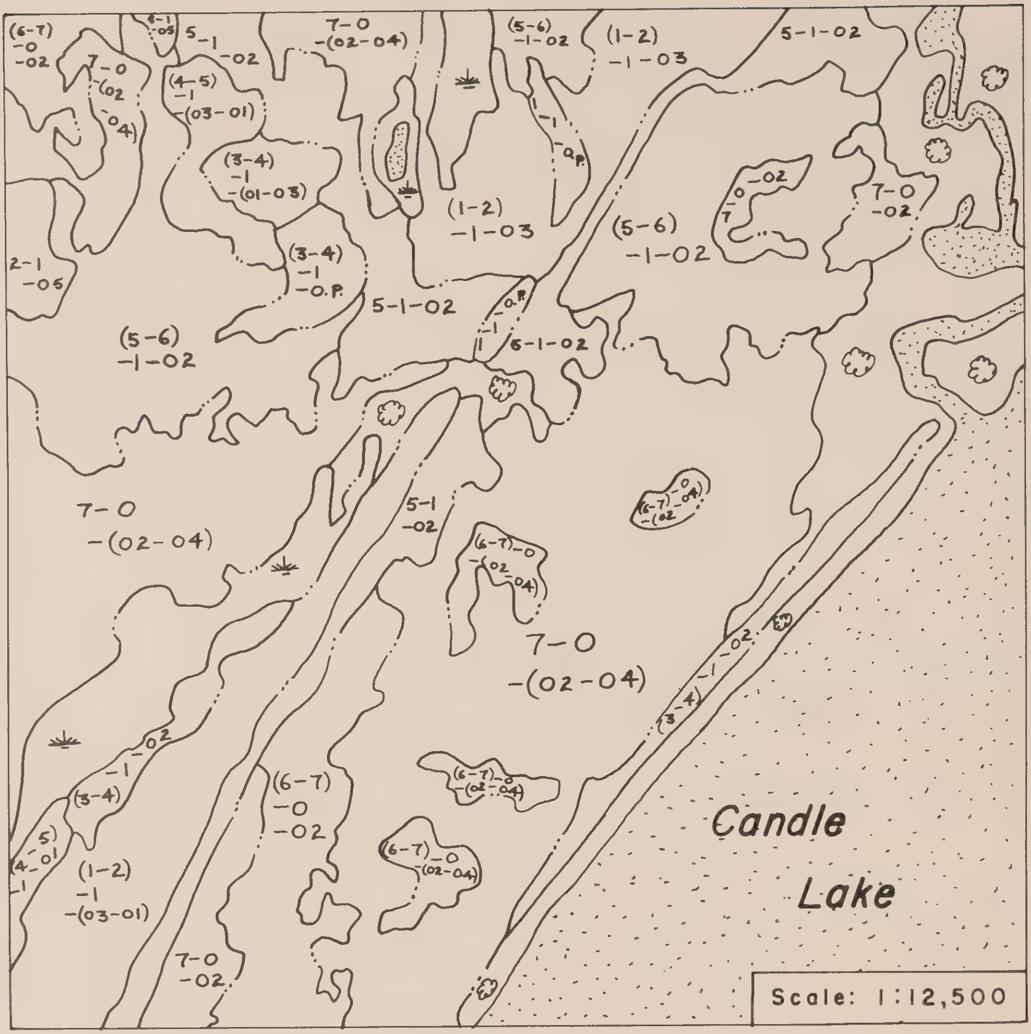


Figure 2: Forest Land Type Map

The mapping is coded in a drainage-texture-species sequence. For example a moderately well drained clay loam supporting a white spruce stand would be shown as 4-3-01.

A complex is shown by the inclusion of member units within parentheses. For example a very rapidly to rapidly drained coarse sand supporting a jack pine stand would be shown as (1-2)-1-03.

Generally, the very poorly drained and to a lesser extent the poorly drained soils are organic. They are depicted with an "O" in place of the texture within the sequence. A poorly drained organic soil supporting a black spruce stand would be shown as 6-0-02.

The very poorly drained sites are usually non-productive.

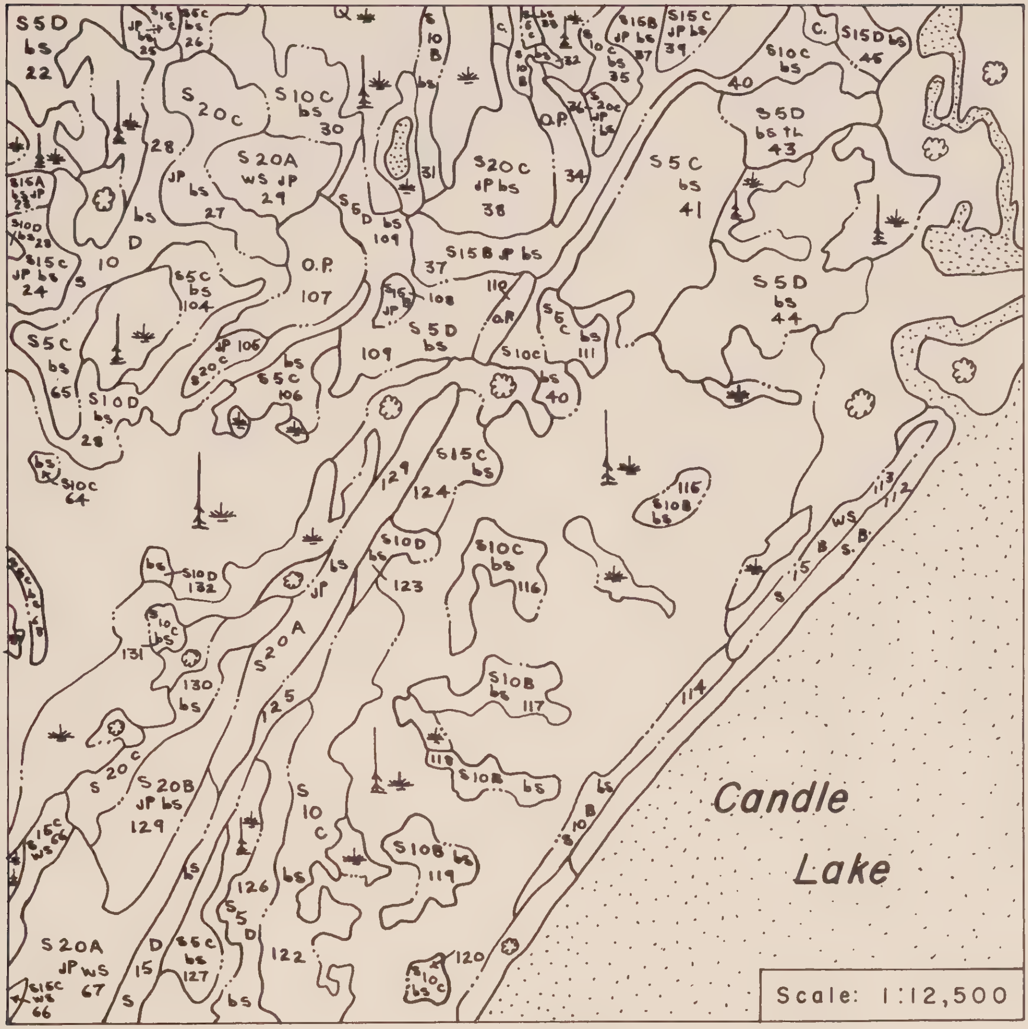


Figure 3: Inventory Maintenance Map

Each forest sub-division is denoted by a letter, numeral and letters showing respectively the species association, height, crown closure, and dominant tree species.

Species Association

Softwood (over 75% softwood by volume)	S
Hardwood (less than 25% softwood by volume)	H
Mixedwood (50% - 75% softwood by volume)	SH
Mixedwood (25% - 50% softwood by volume)	HS

Crown Closure

10% - 30%	A
30% - 55%	B
55% - 80%	C
80% - 100%	D

Height

2.5 - 7.5m	5
7.5 -12.5m	10
12.5 -17.5m	15
17.5 -22.5m	20
Over 22.5m	25

Tree Species

White Spruce	wS
Black Spruce	bS
Jack Pine	jP
Balsam Fir	bF
Tamarack	tL
Lodgepole Pine	lP
Trembling Aspen	tA
Balsam Poplar	bPo
White Birch	wB

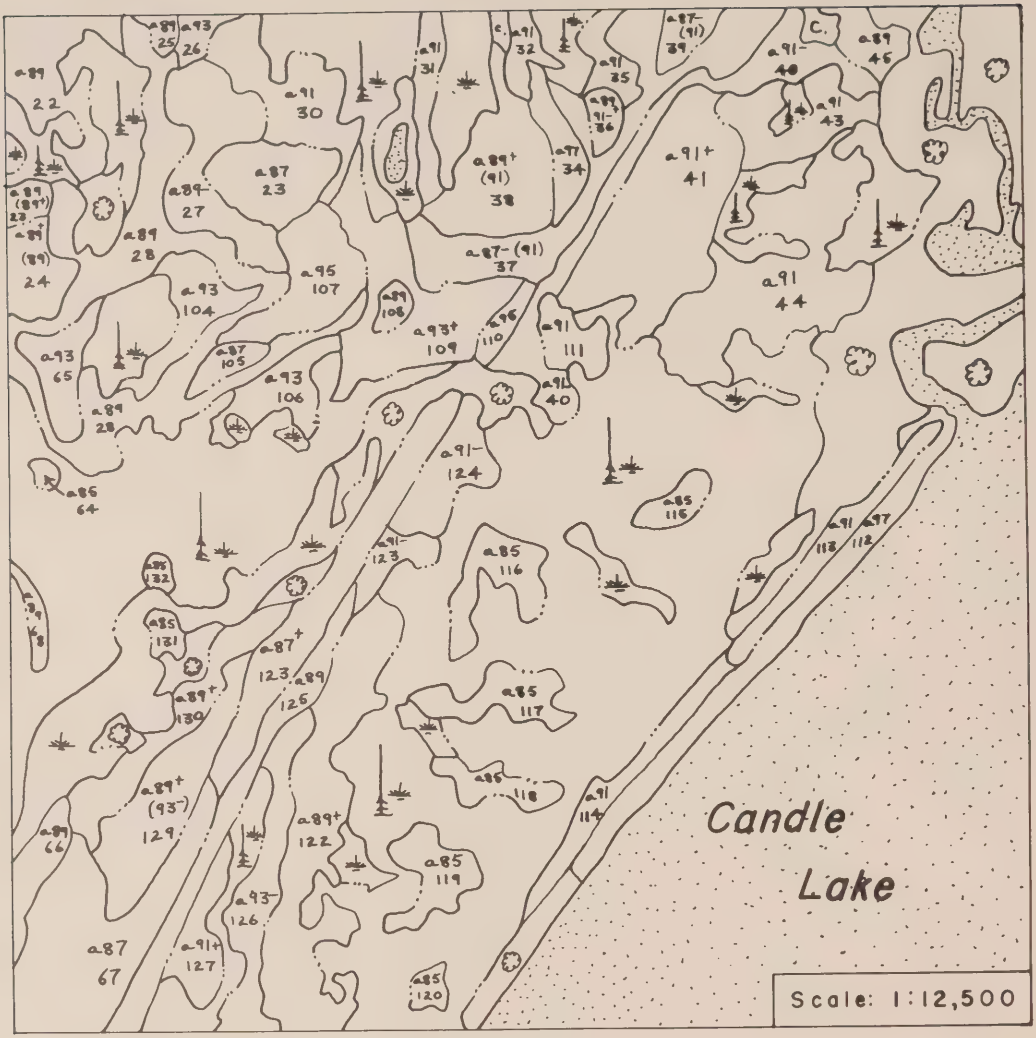


Figure 4: Forest Age Class Map

Forest age is determined from the year of origin. The year of origin of each forest stand is coded, using the mid-point of a 20 year age class.

The map code may be followed by a minus (-) sign; indicating that the year of origin was in the first 10 year period of the class, or by a plus ( ) sign; indicating the year of origin was in the last 10 year period.

Year of Origin	Map Code
1801 - (1810) - 1820	81
1821 - (1830) - 1840	83
⋮	⋮
1961 - (1970) - 1980	97

TERRESTRIAL WILDLIFE HABITAT INVENTORY OF AGRICULTURAL SASKATCHEWAN

R. T. Hart, S. R. Barber,
G. W. Pepper and H. A. Stelfox
Saskatchewan Department of
Tourism and Renewable Resources
Saskatoon, Saskatchewan

ABSTRACT

The Saskatchewan Terrestrial Wildlife Habitat Inventory is being conducted to provide the broad, comprehensive appreciation of terrestrial wildlife habitat in agricultural Saskatchewan (330,000 km²) needed to rationally plan its preservation and management. This reconnaissance inventory is providing biophysical, land use, land tenure, and critical terrestrial wildlife habitat information on a 1:250,000 scale for 21 National Topographic System map areas. This information is presented in a four-part map package and accompanying report for each 1:250,000 map area (15,600 km²). Methodology, presentation of data, costs, progress, problems and applications are discussed.

RÉSUMÉ

Cet inventaire a pour objet d'évaluer globalment l'habitat de la faune dans les régions agricoles de la Saskatchewan, afin d'en planifier la préservation et la gestion. Ce relevé préliminaire a permis d'obtenir des renseignements sur la nature biophysique, l'usufruit et l'utilisation des terres et sur les habitats essentiels, renseignments qui sont présentés sur une carte en quatre parties à l'échelle de 1:250,000 accompagnée d'un rapport pour chacune des 21 zones cartographiques (15,600 km²) du Système National de Reférence Cartographique. On y traite de la méthodologie, de la présentation des données, des coûts, de l'avancement des travaux, des problèmes et des applications. (Trad. Éd.)

INTRODUCTION

The Terrestrial Wildlife Habitat Inventory was initiated in 1975 in response to the need for information concerning the quantity and characteristics of remaining terrestrial wildlife habitat in agricultural Saskatchewan. The Canada Land Inventory (CLI) produced maps for this area depicting the potential capability of land to produce ungulates and waterfowl. These maps were considered inadequate for habitat planning because they dealt with only a few wildlife species, present land use was not considered, and no ecological land classification maps were published (Benson, 1965).

This inventory emphasizes ecological relationships, recognizing that the physical character of the landscape, together with climate and man's activities, largely determines its biological attributes. The necessity for developing a broad understanding of existing terrestrial wildlife habitat, plus time and financial constraints, dictated that the inventory be of a reconnaissance nature.

The Terrestrial Wildlife Habitat Inventory is being conducted by a team of three full-time ecologists who bring together experience in the fields of terrain evaluation, land use, plant ecology and wildlife biology.

METHODOLOGY AND INFORMATION PRESENTATION

This inventory employs the National Topographic System (NTS) 1:250,000 map sheets and involves the preparation of a four-part map package depicting ecological *land systems* (Figure 1), present land use, land tenure and critical terrestrial wildlife habitat for each NTS map area. The Land System map serves as a base map with the other three presented as overlays providing a visual appreciation of physical,

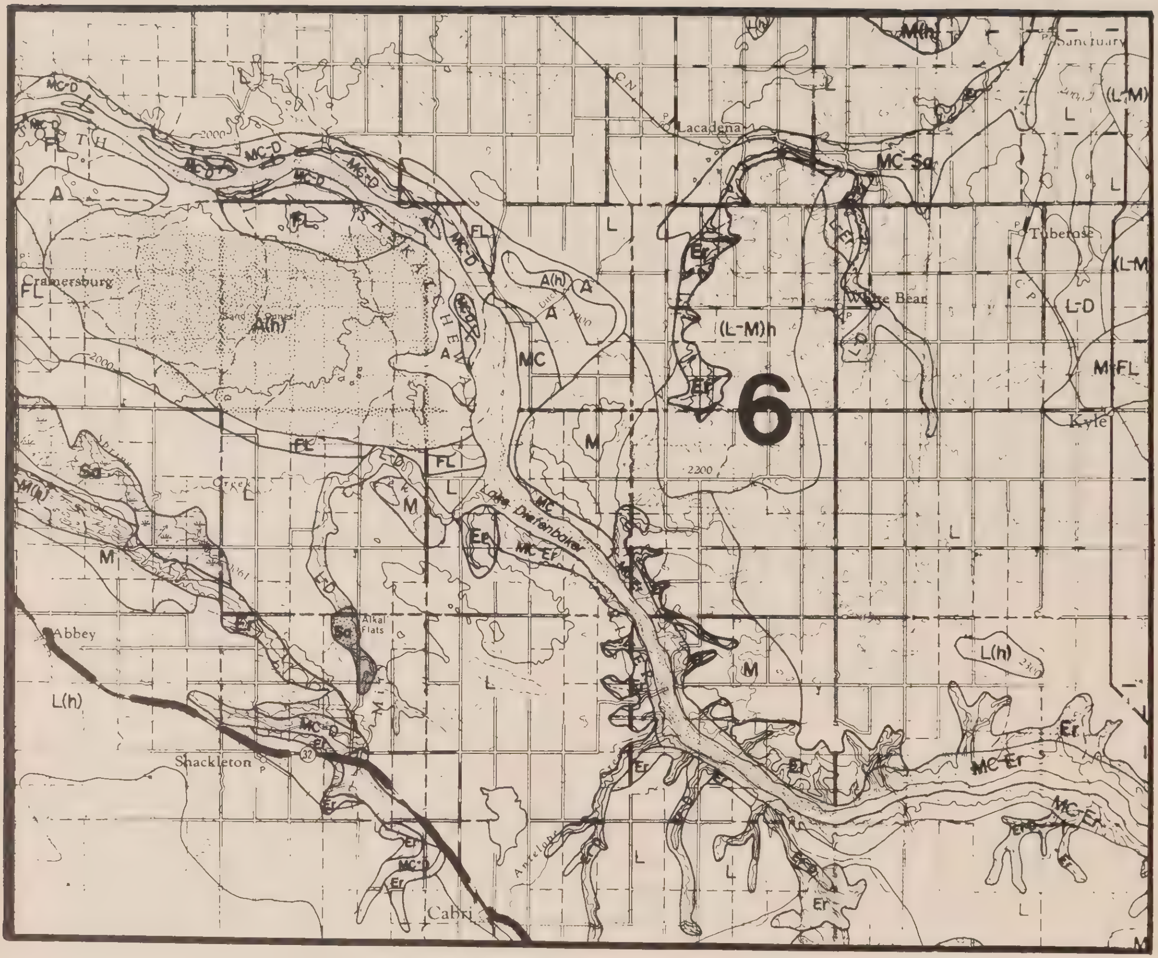


Figure 1: A portion of the Land System map of the Prelate map area (NTS 72K) illustrated here at a scale of about 1:250,000. Appendix I outlines definitions of the land system and relief classes. Legend: M - Moraine, FL - Fluvial Lacustrine, L - Lacustrine, Er - Eroded, A - Aeolian, Sa - Saline soils, MC - Meltwater Channel, D - Delta. The large numeral 6 refers to a Game Management Zone.

biological and cultural interrelations. The map package is accompanied by a major report which presents quantitative and qualitative information pertinent to each of the four maps.

Land System Map

The classification and mapping of land systems (Figure 1) provide the basis for the biophysical characterization of wildlife habitat and the subsequent interpretations concerning the capability of the habitat to support wildlife species. These ecological units (Appendix I) are characterized by distinctive patterns of landforms, soils, vegetation and water bodies (SBLC, 1969). Heavy reliance is placed on landscape genesis and topographic expression in the placement of land system boundaries, using the most recent soils and geological information, as well as air photo interpretation (LIFT, 1:80,000). The land systems are set within a soil zone framework which closely reflects climatic variation, the associated natural vegetation and surface soil characteristics. Characteristic vegetation is not indicated on the Land System map, but is described in the accompanying written report. Only the dominant plant species are considered, with special emphasis placed on trees and shrubs because of their importance to game species.

Present Land Use Map

The mapping of present land use (Figure 2) is intended to provide information on the amount and distribution of native habitat. High level, black and white aerial photographs (LIFT - 1970), and field checks, are utilized in the classification of each map area, using five land use classes (Appendix II). Land use units are fairly large and homogeneous, usually no less than 2 mi^2 (5 km^2) in area. An exception to this minimum size criterion occurs in southeastern Saskatchewan where the paucity of uncultivated lands and the importance of the remaining native vegetation necessitated that all Class 1 land units of 1 quarter-section (65 ha) and larger were mapped.

Land Tenure Map

The Land Tenure map (Figure 4) depicts lands as being privately or crown owned. This distinction is important for land use planning purposes because of limited government control over private land. Crown lands are further identified as: privately leased provincial land, government administered pastures (PFRA, provincial or Co-op), Provincial Land Bank or Wildlife Development Fund lands, and other categories such as provincial and national parks, and Indian reserves. The information was obtained from the Saskatchewan Department of Agriculture.

Critical Terrestrial Wildlife Habitat Map

The Critical Terrestrial Wildlife Habitat map (Figure 5) identifies the best seasonal and year-round terrestrial wildlife habitat in each map area. These areas were considered critical to the maintenance of populations of the species indicated, although additional habitat is often required to meet all the needs of a population. In most cases the critical habitat is in a native state; however, cultivated lands may be included for species such as white-tailed deer which rely heavily on mosaics of native habitat and cultivated land.

Priority has been given to the identification of critically important habitat for game and rare or endangered species. This priorization results from various political and economic considerations and a general lack of ecological information for most non-game species. It is believed that the critical wildlife habitats identified will provide substantial non-game habitat as well. The final delineation of this habitat results from the synthesis of such relevant information as the CLI capability maps, the Land System, Present Land Use and Land Tenure maps of this inventory, wildlife ecology and population data, and field evaluations made during the current study.

Written Report

The written report is considered an essential element of this inventory, providing an illustrated bio-physical characterization of the land systems present. Discussion and quantitative data are also presented concerning the Present Land Use, Land Tenure and Critical Terrestrial Wildlife Habitat maps. Wildlife habitat preservation and management proposals and wildlife ecology are considered for each land system.

TIME AND COST CONSIDERATIONS

Ecologists' salaries and field expenses comprise the major cost of conducting this inventory (Table 1). Most of an ecologist's effort is devoted to compiling and analyzing data and presenting this information in map and written form. About one-quarter of the ecologist's time is spent in the field determining land system-vegetation relationships, gathering wildlife data and updating land use

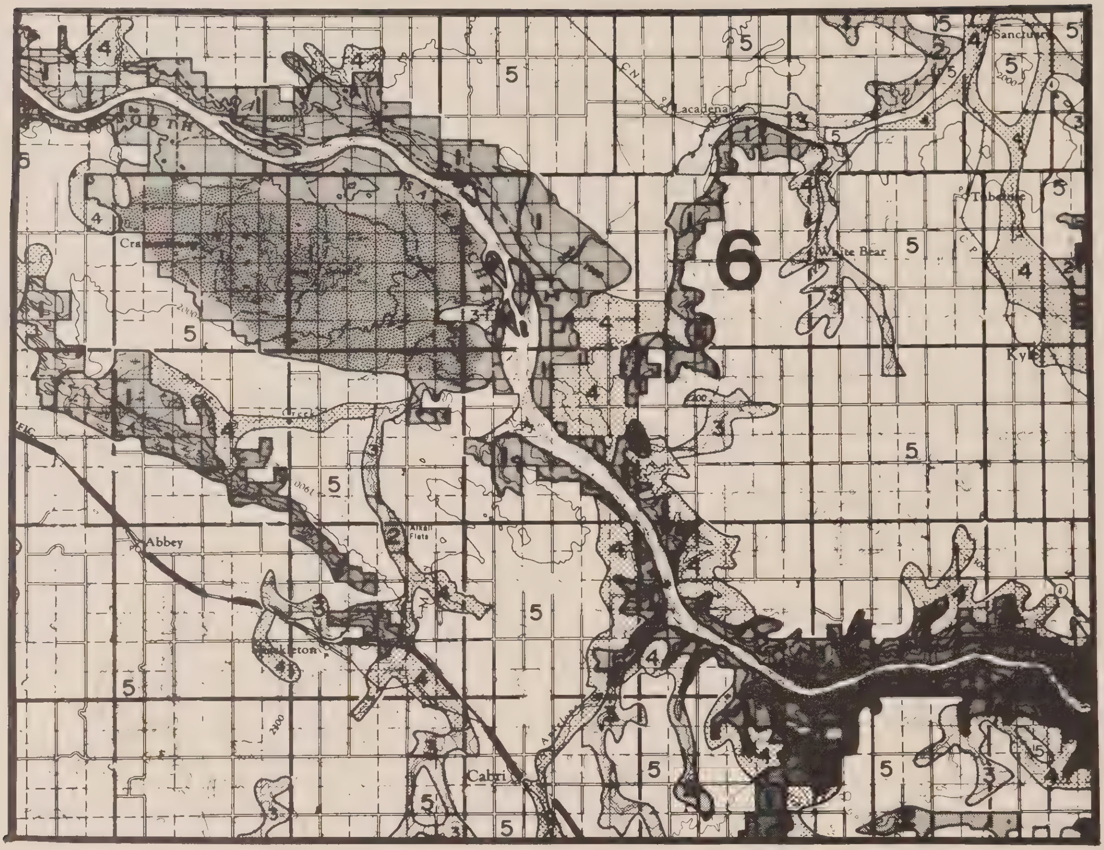


Figure 2: The portion of the Present Land Use overlay map corresponding to the area illustrated in Figure 1. Land Use Class 1 units (dk. shading) represent areas which predominantly support native vegetation while Class 5 lands (no shading) are almost entirely cultivated, supporting annual grain crops. Refer to Appendix II for complete definitions of all land use classes and subclasses.

information derived from air photos. Ground checking is the principal method used in determining land system-vegetation relationships while land use and wildlife data are gathered mainly through work with a fixed-wing aircraft.

TABLE 1
TIME AND COST CONSIDERATIONS
Per 1:250,000 Map Area (15,600 km^2)

Expense Item	Time (days)	Cost ($)
Personnel:		
Ecologist(s)	140	10,700
Draftsperson	30	1,650
Typist	15	600
Field Work		4,500
Publishing		2,800*
Total		20,250
Cost/mi^2		3.40
Cost/km^2		1.30

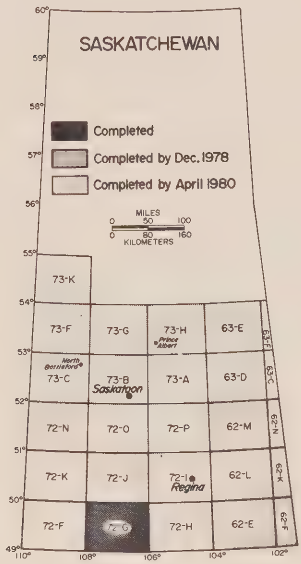
*Includes 50 colored Land System maps, 6 copies of each overlay, 25 copies of report and 3 mat positives of overlay maps (for blueprinting).

Table 1: Manpower required and cost to complete the Terrestrial Wildlife Habitat Inventory of a single 1:250,000 map area in agricultural Saskatchewan.

PRODUCTION TO DATE

One 1:250,000 map sheet package and accompanying report has been completed (Figure 3). Eight map area productions are in various stages of completion and will be available by the end of 1978. Map packages are available for five of these map areas (72F, 72H, 72J, 72K and 72N). Land Use maps have been printed for the remaining three sheets and Land System maps for two (62L-M and 62M-N). Land Tenure maps are available in blueprint form for all of agricultural Saskatchewan, the equivalent of approximately 21 map areas.

Figure 3: Coverage of Saskatchewan Terrestrial Wildlife Habitat Inventory of 1:250,000 NTS map areas.



PROBLEMS

Consistency in land use mapping detail has been difficult to maintain due to regional variation in land use patterns. For example, an increase in land use intensity from southwestern to southeastern Saskatchewan is manifested in a general decrease in quantity and unit size of uncultivated land. This, combined with the accelerated loss of important wildlife habitat in this region, has necessitated mapping uncultivated lands in greater detail.

Changes in the amount of cultivated land could quickly make the land use maps of the inventory obsolete. Aerial reconnaissance has been utilized in assessing changes which have occurred since 1970 while the use of LANDSAT data to provide annual updating is being investigated.

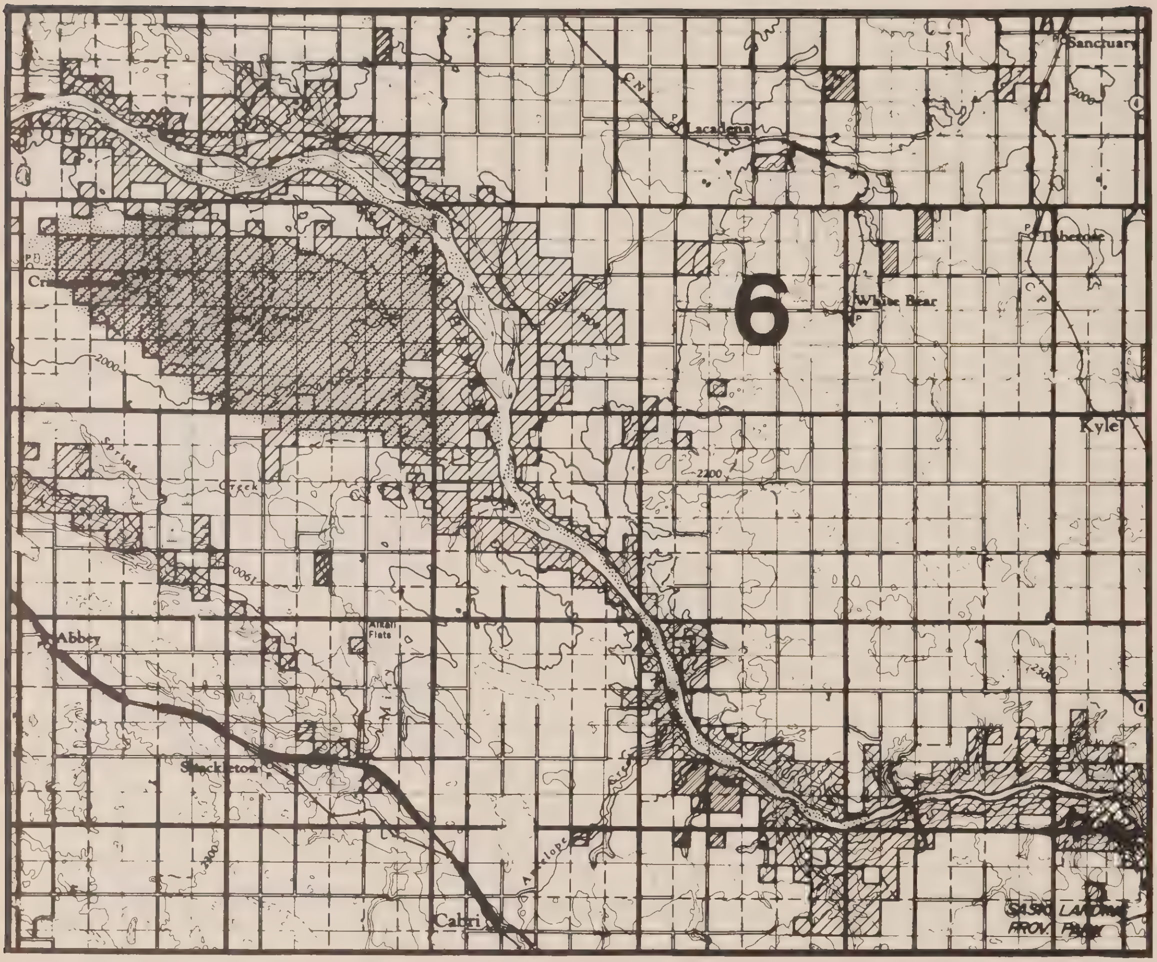


Figure 4: The portion of the Land Tenure map corresponding to the area illustrated in Figures 1 and 2. Categories of crown land are distinguished by variations in cross-hatching.

This inventory relies heavily on existing resource information. The low priority attached to the new soil survey has resulted in only partial coverage of agricultural Saskatchewan. This results in variable accuracy and information content being achieved in the land system mapping. A lack of plant and animal ecology information has also hampered the effectiveness of this biophysical inventory.

It was difficult to predict and adequately define all the land system categories that were likely to be encountered in such an extensive mapping project. There is always a tendency to create new classification units to accommodate newly encountered types of land; however, this is done at the risk of complicating comparisons with previously mapped areas. To this point we have found it necessary to add only one land system to the 12 initially defined, and only one more is anticipated.

APPLICATIONS

The Saskatchewan Terrestrial Wildlife Habitat Inventory is providing an ecologically sound basis for the preservation and management of wildlife habitat and for general land use planning in agricultural Saskatchewan. To date, inventory data has been utilized for several wildlife management and research purposes. Other uses are suggested and anticipated.

Wildlife Habitat Preservation and Management

The information made available by the inventory is of use to the Fisheries and Wildlife Branch in providing wildlife input into crown pasture land development, and to the provincial Wildlife Development Fund for purposes of habitat acquisition and management. The future establishment of 'ecological reserves' in Saskatchewan could be aided by our inventory data.

General Land Use Planning

This inventory is expected to prove useful to the Saskatchewan Department of the Environment in formulating an overall land use plan for Saskatchewan. The Saskatchewan Department of Municipal Affairs has requested the inventory data to assist them in land use zoning within a 40-mile (74 km) radius of major urban centres.

Wildlife Management

The information produced by the inventory has come into immediate use for wildlife management in the province. The network of population census areas is being rationalized, beginning with those areas chosen to monitor sharp-tailed grouse. Attempts are being made to determine the carrying capacity of a game management zone for a species, using the habitat information provided. A most significant application will be the impending refinement of the entire game management zone system to more closely reflect significant terrestrial habitat variations.

Research

Research activities involving renewable natural resources, notably wildlife but including others, will benefit considerably from the inventory. For example, the selection of relevant terrestrial wildlife research problems and study areas will be enhanced by the broad regional perspective provided. Professionals other than wildlife ecologists that have expressed interest in using the inventory for research purposes include hydrologists, fisheries ecologists and archeologists.

Environmental Impact Assessment

Information derived from the Terrestrial Wildlife Habitat Inventory will assist in the rapid and accurate assessment of potential environmental impact from major industrial and agricultural development proposals. Many such impact assessments will be required in Saskatchewan in the future as a result of legislation proposed by the provincial government. The inventory products will not only be useful in conducting the impact studies, but will also assist the responsible government agency in screening development proposals to determine which ones require impact assessments and what scope and complexity of studies are needed. To date, the information obtained through the inventory has been utilized in conducting impact studies for several pipeline proposals for southwestern Saskatchewan.

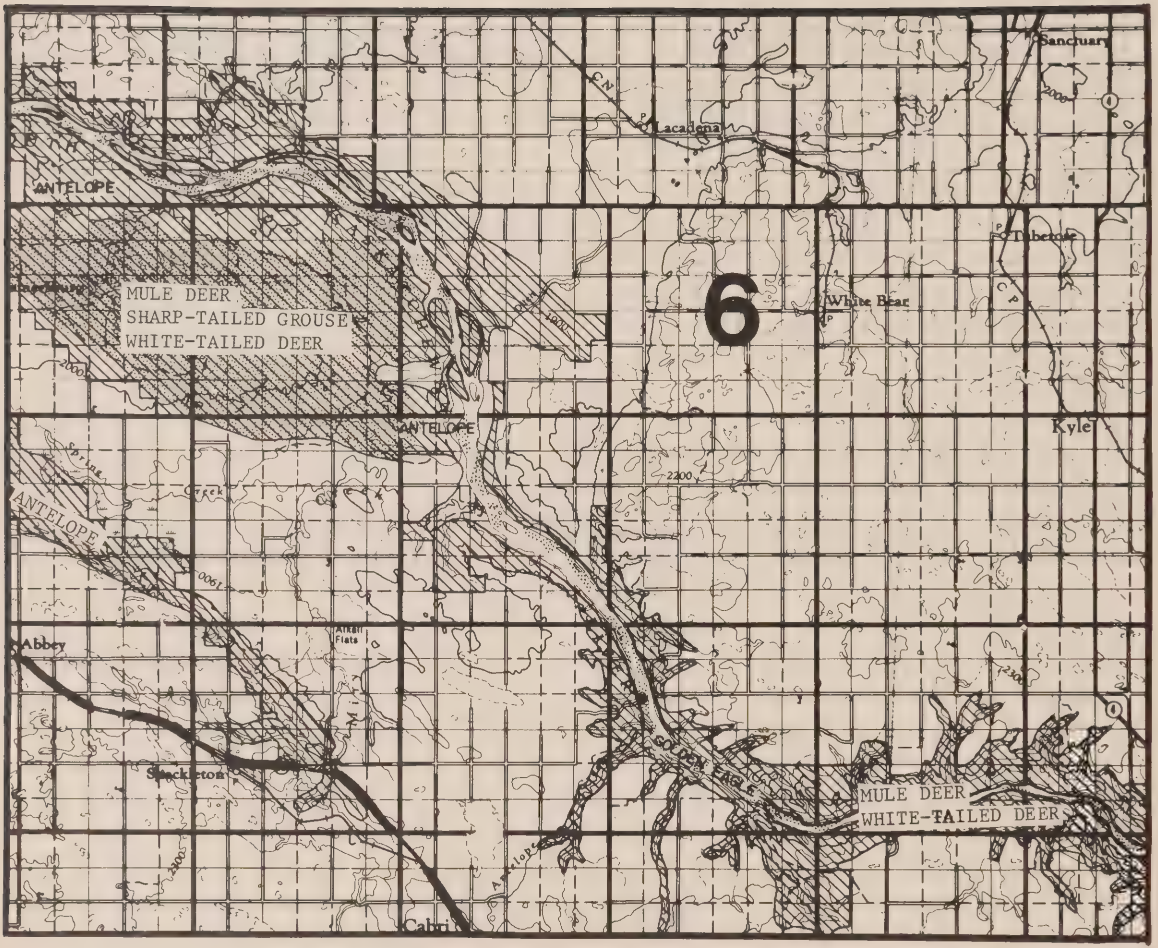


Figure 5: The portion of the Critical Terrestrial Wildlife Habitat map overlay corresponding to the area illustrated in Figures 1, 2 and 4. Cross-hatching indicates areas considered as critical to the maintenance of present populations of species listed. (The order of listing has no significance.)

Education and Communication

It is believed that the Terrestrial Wildlife Habitat Inventory will serve as an education and communication tool whereby the interrelationships of biological, physical and cultural attributes of the landscape are better understood. In so doing it will provide an ecologically meaningful context in which to resolve land use conflicts and hopefully lead to a more rational approach to resource utilization in agricultural Saskatchewan.

CONCLUDING REMARKS

The Saskatchewan Terrestrial Wildlife Habitat Inventory is providing, for the first time, a broad appreciation of terrestrial wildlife habitat resources in agricultural Saskatchewan. It is supplying information needed for the preservation and management of wildlife habitat on a regional basis, and is also proving useful in general land use planning.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge George Duff and Sandy Dunlop for drafting the figures, Lois Koback for typing the numerous drafts, Verna MacKinnon for editing, and John Waddington for the preparation of the plates.

The Terrestrial Wildlife Habitat Inventory is funded jointly by the Saskatchewan Department of Tourism and Renewable Resources and the federal ARDA program.

REFERENCES

Benson, W. A. 1965. Outline of the Canadian land capability classification for wildlife. Canada Land Inventory, ARDA.

Subcommittee on Biophysical Land Classification. 1969. Guidelines for Biophysical Land Classification. (comp. and ed. by D.S. Lacate). Can. For. Ser. Publ. No. 1264. Ottawa. 61 p.

APPENDIX I
DEFINITIONS OF LAND SYSTEMS AND TOPOGRAPHIC CLASSES

This is an ecological land classification that strongly reflects land genesis, but is not in all cases strictly defined according to it.

The map scale and reconnaissance nature of the classification have combined to prohibit the establishment of map units smaller than approximately 1 mi^2 (2.6 km^2) and narrower than approximately .25 mi (.4 km).

Low and high relief phases of some land systems are recognized, however, only the high relief (h) map units are symbolized. Low relief lands roughly comprise the flat to very gently rolling topographic classes of the soil survey. The high relief phase approximates the gently to strongly rolling classes.

Moraine (M): Lands formed predominantly by unsorted glacial deposits (till), comprising undulating plains, "knob and kettle" terrain and other topographic variations.

Fluvial (F): Lands formed by coarse-textured (sandy to gravelly) glacio-fluvial deposits.

Fluvial-Lacustrine (FL): Lands formed by glacial, fluvial-lacustrine, sandy deposits.

Lacustrine (L): Lands formed by fine-textured (mostly silt and clay) glacio-lacustrine deposits.

Aeolian (A): Lands formed by glacial sand deposits subsequently reworked by wind; high relief phase characterized by dunes.

Solonetzic Soil (Sol): Lands characterized by solonetzic soils (hard, compact subsoils). Many areas possess micro-relief due to shallow "burn-out" pits.

Saline Soil (Sa): Lands characterized by soils with high concentrations of soluble salts (alkaline soils); flat to depressional, poorly drained.

Alluvium (Av): Lands formed largely by fine-textured alluvial deposits; frequently flat and poorly drained.

Drainage (D): Complex assemblages of land associated with major, usually meandering, streams. Comprises various alluvial deposits

and other features of active floodplains, associated valley and other intimately associated lands.

Eroded (Er): Strongly dissected lands mostly adjacent to major valleys and on escarpments --also includes areas of slumping.

Meltwater Channel (MC): U-shaped valleys comprising glacial meltwater channels and spillways, frequently characterized by eroded walls, alluvial and/or saline alluvial deposits, lakes and streams.

Bedrock (BR): Lands exhibiting strong physical bedrock control, mostly characterized by a thin mantle of glacial deposits, dissection, highly variable relief, high elevations and bedrock exposures. Various categories of this broadly-defined land system are recognized.

APPENDIX II
DEFINITION OF LAND USE CLASSES

The five land use classes are defined according to the proportion of total area supporting native vegetation and introduced perennial forage crops. In classes 1-4, the ratio of native vegetation to introduced perennial forage crops is at least 3:1, except where otherwise indicated by letters representing subclasses. Class 5 units are not subclassified.

For the purposes of this classification, land includes uplands plus wetlands which are temporarily inundated.

Class 1: 90-100% of the land supports native vegetation and/or introduced perennial forage crops. The remaining 0-10% is used to produce annual crops, and/or for other purposes not entailing native vegetation or introduced perennial forage crops.

Class 2: 50-90% of the land supports native vegetation and/or introduced perennial forage crops. The remaining 10-50% is used to produce annual crops, and/or for other purposes not entailing native vegetation or introduced perennial forage crops.

Class 3: 30-50% of the land supports native vegetation and/or introduced perennial forage crops. The remaining 50-70% is used to produce annual crops, and/or for other purposes not entailing native vegetation or introduced perennial forage crops.

Class 4: 10-30% of the land supports native vegetation and/or introduced perennial forage crops. The remaining 70-90% is used to produce annual crops, and/or for other purposes not entailing native vegetation or introduced perennial forage crops.

Class 5: 0-10% of the land supports native vegetation and/or introduced perennial forage crops. The remaining 90-100% is used to produce annual crops, and/or for other purposes not entailing native vegetation or introduced perennial forage crops.

Subclasses

N-T: The ratio of native vegetation to introduced perennial forage crops is less than 3:1 but at least 1:1.

T-N: The ratio of native vegetation to introduced perennial forage crops is less than 1:1 but at least 1:3.

T: The ratio of native vegetation to introduced perennial forage crops is less than 1:3.

Example

2-N-T: The class (2) indicates an area of land comprised of 50-90% native vegetation and introduced perennial forage crops. The subclass (N-T) indicates the ratio of native vegetation to introduced perennial forage crops is at least 1:1 but is less than 3:1.

ENVIRONMENTAL INFORMATION IN A PLANNING/ MANAGEMENT CONTEXT

R. Lang
Faculty of Environmental Studies
York University
Downsview, Ontario

ABSTRACT

Environmental problems present a dilemma: while environmental systems function in an interrelated holistic manner, institutional systems intended to deal with these problems tend to function in a disjointed separated manner. The more complex the natural/human aspects of the problem and the more agencies involved in implementation, the less appropriate are holistic prescriptions (comprehensive data base, comprehensive plan, super-department). More attention must be given to the needs of users and those affected by planned actions, and instead of an ends-to-means sequwnce from information to planning and implementation, there must be a diversity of planning inputs throughout management processes. Opportunities to diversify arise in both the horizontal and vertical dimensions of any organization. A building block approach allows discrete initiatives to proceed incrementally, with the intent of eventually linking them within an integrated environmental management framework.

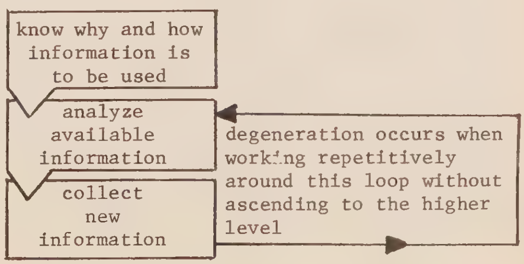
RÉSUMÉ

L'étude des problèmes environnementaux n'est certes pas facile: tandis que les systèmes écologiques évoluent par interactions selon la théorie holiste, les gouvernements s'attaquent à ces problèmes de façon dispersée. Plus les aspects écologiques (rapports entre l'homme et la nature) des problèmes sont compliqués, et plus le nombre des organismes engagés dans la mise en application est élevé, moins les moyens holistes s'avèrent adéquats (base de données et plan d'ensemble, superministère, etc.). On doit accorder une plus grande attention sux besoins des usagers et des personnes touchées par la planification. De plus, au lieu d'employer une approche linéaire pour acheminer les données nécessaires à la planification et à la mise en application, il importe de diversifier les sources de la planification tout au long du processus de gestion. Cette diversification peut se faire tant verticalement qu'horizontalement dans la structure de l'organisation. Une approche modulaire permet aux initiatives de s'épanouir graduellement et de s'intégrer dans un cadre de gestion de l'environnement. (Trad. Éd.)

INTRODUCTION

Most of the people associated with the CCELC are producers of environmental data. I am more a consumer, as a planner and in my environmental assessment work. One of your 'clients', therefore, stands before you to share some views from that other side.

A familiar theme at this and other CCELC meetings is the concern for the use of data being generated, not just how information is used but whether it actually influences decisions and subsequent actions. Many of us, without wanting to, get caught up in the "degeneration syndrome" (Medford, 1973). Information gathering becomes an end in itself, perhaps even a substitute for action, in the hope that the data will inspire flashes of insight and reveal their significance to us (computers simply speed up this aimless activity). Substitute "plan making" for "information gathering" and you can see that planners experience a similar problem.



Degeneration can be avoided by focusing attention on the connection, both in understanding and action, between our work and the subsequent uses to which it is put. Planning serves implementation/management functions; data serve both planning and management. Data gathering and planning, therefore, must be conducted within their wider management contexts.

Elaborating that point is this paper's main purpose. It begins by drawing some lessons from a recent environmental planning experience, then describes the nature of environmental planning and environmental problems generally, and finally outlines an alternate management response capable of forming a framework for data gathering and planning. Throughout, the assumption is that the data we generate and the plans we produce, no matter how professionally or scientifically competent and personally satisfying, have value only in relation to the environments they serve to enhance.

LESSONS FROM PRACTICE

In 1976 Audrey Armour and I were asked to assist the Town of Oakville, a community of 60,000 about 40 km west of Toronto on the shore of Lake Ontario, to conduct an in-house planning exercise aimed at ensuring that natural environment considerations received their deserved priority in municipal actions. The environmental planning process was to (a) assemble for the non-urban part of the municipality a data base to guide urban expansion and action to protect environmental quality, (b) formulate policies accordingly, and (c) set up an environmental review process for public and private development proposals. Unforfunately, the planner who initiated the exercise left the Town's employ before the study was completed; the Town became caught up in an extended Ontario Municipal Board hearing on its official plan; and the budget, contributed by the provincial Ministry of Housing (which otherwise remained aloof from the study), ran out and was not renewed. As a result, the exercise terminated prematurely. We decided, on our own and at our expense, to document the findings and offer recommendations in *Oakville Environmental Report: A Case Study in Environmental Planning* (Lang and Armour, 1977).

Note, therefore, that this case does not refer to an environmental 'plan' or to a course of action endorsed by a municipal government. Still, the Oakville exercise provided some valuable lessons that have relevance here:

Where to begin — Launching a planning exercise with a comprehensive information inventory, the conventional approach, is not necessarily that useful, especially if you are concerned less for the quality of the plan than for the quality of the environment. It is often quite difficult to prescribe in advance the data priorities; data obtained can unduly influence the subsequent plan; and the time, money and staff resources consumed can detract from the planning task. Moreover, data collection directs attention to the community's environment but the problems it faces are also a function of the numerous jurisdictions and interests whose actions affect that environment. Until these are better understood, data collectors may be turning over the wrong rocks.

The available data myth — It is often said that the information already exists; it is just a matter of reorganizing and presenting it properly. We definitely did not find this to be so. A recent look at municipalities across Canada by the Lands Directorate confirms the general validity of this finding.[1] Environmental information that was available seldom matched our needs. Conversely, little information was readily available to answer our questions (e.g.: What are the environmental resources of this area? What interrelationships are at work? To what extent are the area's environmental resources valued locally? What threatens them most? What options are available to protect them?). It's not surprising that the needed data do not exist; they are gathered for purposes other than that of determining the condition of a municipality's environment and how it is changing. Rarely, if ever, is that done.

An insufficient time perspective — Municipal officials and others (which often includes planners and environmental consultants) tend to accept recent events as the pre-ordained future. This attitude overlooks the historical context of environmental change. Today's community is the result of forces firmly rooted in the past, some long time horizons are involved, and some fundamental developmental changes may lie just ahead. In Oakville's case, we concluded that the town had developed not in a smooth sequence but through a series of stages, each representing a plateau where new conditions produced a unique set of man-environment relationships.

[1] Wiken (1979) reports that all Census Metropolitan Areas had information on topography and many had basic data on geology and soils but few or none had data on forestry, climate, hydrology or wildlife.

Stage I, *Survival* (Indian and European settlement), was characterized by a strong dependency on the immediate natural environment but had little impact on it. By contrast, in Stage II, *Resource Exploitation* (1820 - 1860), rapid population and economic growth was accompanied by severe environmental degradation contributing to the economic collapse that ended this stage. During Stage III, *Landscape Recovery* (1860-1940s), the area's depleted soils, polluted streams and economy returned to a state of stability which ended after the war. The current Stage IV, *Rapid Urbanization*, has seen industrial development, sudden population growth and economic prosperity, but at the cost of much higher resource/energy use than ever before and unprecedented environmental stress manifested as waste, pollution, and some alarming side effects. It seems clear that this stage cannot continue much longer (and that applies to most if not all of Canada) which means another development stage-change may lie just around the corner. If that is so, experience of the past 30 years will not be that helpful in planning for the next 30 (planners are still talking about the year 2000 as though the future is merely an extension of the past with the bad things removed).

Excessive growth projections — One result of an insufficient time perspective is that projections of future urban growth, based on trends over the past 10-15 years, tend to be excessive. Despite the fact that the exponential growth recently experienced by many urban areas cannot continue indefinitely, municipal plans such as Oakville's continue to foresee eventual urbanization of all their territory (and often more) ; it is just a matter of time they argue. The non-urban territory may contain the municipality's most valued environmental resources. Using more realistic growth projections, the planners (including those who plan major sewer, water and transportation services which both serve and attract urban growth) might see another set of options for much of this territory: continued agriculture, wildlife habitats, watershed and aquifer functions, passive recreation and amenity, and a hedge against an uncertain future that may demand greater self-sufficiency.

The minimal impact fallacy — The commitment to urbanize an area, usually made on the basis of highly generalized data rather than specific studies of environmental systems, involves transforming one kind of environment to another that is fundamentally different. Three dubious assumptions underlie this commitment: first, that adverse environmental impacts can be 'minimized' by planning and control of development; second, that any loss of environmental resources (such as vegetation) can be compensated for by environmental design and landscape treatment; and third, that somewhere a non-urban fringe will continue to exist, providing 'relief' from the urban area and protection for certain valued environmental resources such as wildlife. What this naive set of assumptions overlooks are the inevitable loss of quality that accompanies urban development, with its peculiar environmental stresses and high-density concentrations; the poor track record of municipal plans in guiding and controlling development, especially from an environmental perspective (Lang and Armour, 1976); the loss of diversity and system functions that takes place when natural environments are substituted for; and the fact that urbanization *itself* has become the critical determinant of environmental quality. This last point is subtle but significant. It is not merely a matter of the occasional road or sewer line that destroys some resource. Rather, the entire urbanizing *process* (often, even the expectation of such a process) signals the environmental transformation. Once that happens we are dealing with a different entity altogether and not one that we understand or control very well.

The need for environmental management — Environmental management means a municipality employing all its powers affecting the natural/human environment with foresight and in an informed, coordinated manner in accordance with a clearly established set of environmental policies. It involves *information* (a data base for subsequent plans and policies, key decisions and programs, *direction* (the purposes underlying municipal initiatives and the political will and leadership to make things happen), and *implementation* (actions taken by the municipality, directly and indirectly, to accomplish its environmental objectives). Environmental management, one aspect of municipal governance rather than a veto over everything else, is required (a) to compensate for loss of municipal control over and increasing interference of urban industrialization with natural environment capacities, and (b) to justify withholding from urban development a substantial part of the municipal territory. In this regard, Oakville (in the company of numerous other settlements) can be seen as a 'downstream community'. Its environmental quality is affected by many actors, public and private, whose actions are uncoordinated, whose interests differ, and who are often located far away. Environmental problems, therefore, generate a need for coordination over large areas and many interests.

The Oakville experience taught a couple of other lessons as well. First, when intervening with a new approach such as environmental planning, make sure you either have or develop solid support at the popular[2], political, administrative *and* technical levels. And, second, clarify the concepts which guide your interventions and help make them understandable to others. The second point is addressed next.

THE NATURE OF ENVIRONMENTAL STUDIES

There are various purposes *in* environmental planning, depending on specific conditions (for instance, compare planning for wildlife management, floodplain protection, soil conservation, recreation activities and urban development). At a more abstract and generalizable level, however, I would argue that the basic objective *of* environmental planning is *to guide human activity toward enhancement of the capacity and quality of given natural/human environments:*

Enhancement — includes conservation, protection, preservation, creation, restoration and improvement of environments that concern us.

Capacity — is of two kinds (Bishop, 1974): supportive (supply of resources for certain activities) and assimilative (handling wastes from certain activities). The concept of environmental capacity suggests limits in the environment's ability to process materials, waste and energy (related to resiliency, as in Hill, 1975 and Holling and Goldberg, 1971). Beyond these thresholds, human activities will lead to undesirable changes in the receiving environments.

Quality — while capacity tends to be more objective, quality has a stronger subjective component (though capacity and quality mix subjectivity and objectivity). An objective measure of quality, for example, is provided by air pollution standards which are defined in terms of 'non-equilibrium' with respect to certain physical, chemical and biological parameters, and which are intended to protect the quality of air in terms of human health, property, vegetation and amenity. Such measures of quality, however, are based upon human perception and judgement. Though qualities may exist without man (i.e., the setting for quality), it is man's judgements that define quality (i.e., how that setting is experienced). Such judgements (Schwarz et al, 1976) are both *individual* (each person constructs reality separately even though certain universals may cut across individual perceptions) and *consensual* (a group may attach some value to an environment, not necessarily the same as individual values). Consensual judgements, referring to broad groupings, form the basis for environmental quality planning.

Environmental quality tends to be the major concern in urban/human environments; environmental capacity figures larger in non-urban 'natural' settings. Inevitably, however, we deal with natural/human environments and there, capacity and quality are closely related. Consider, for example, an important difference between human environments (where man, technology and human culture clearly dominate) and natural environments (where man's role and influence are less). In a natural environment, carrying capacity limits population size; organisms die off when capacity is exceeded. In human environments, however, the more likely consequence is that the environment will merely change with a consequent reduction in its quality (something that is well understood in recreation planning, for example). Definitions of capacity in relation to human environments, therefore, necessarily include quality considerations. As one example, recreational carrying capacity has been defined as "the level of recreational use above which changes that occur in the environment (or experience) are considered by management to be acceptable" (Rodgers, 1976). This introduces the concept of "perceptual capacity": the amount or degree of damage that can occur before we perceive the environment different than before (Godschalk and Parker, 1975).

Capacity and quality, while tied to intrinsic environmental conditions and the perceptions of those experiencing the environment in question, are also a function of deliberate *management* decisions. Recreational agencies, for example, in planning a park and determining

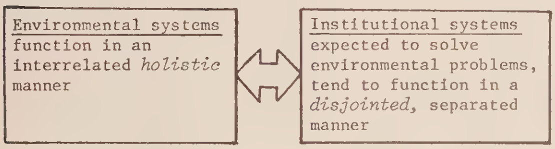
[2] "Popular" is stressed because environmental planning calls for a special kind of public participation. The planner's problem is that public involvement in planning is demanded but, if *initial* public views on environmental resources are directly incorporated in the plan, the result will be disastrous if people (as is so often the case) undervalue environmental resources. An iterative process of securing views, generating and putting out new information on environmental systems and their value to human activities in that particular area, obtaining further public views, perhaps repeating the cycle, is needed. In other words, participation must be a learning process; if it is merely a one-shot effort it may well be counter-productive in an environmental sense.

what facilities to provide, define the character of the recreational experiences deemed desirable and the degree of use to be allowed. Environmental planning oriented to capacity and quality, therefore, does not merely serve management processes, rather the relationship is reciprocal.

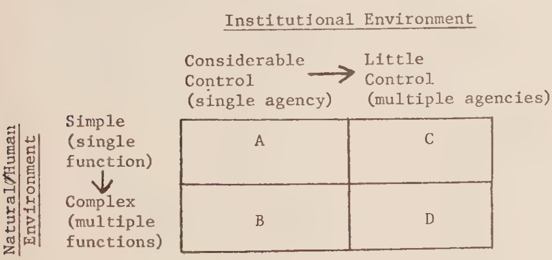
THE NATURE OF ENVIRONMENTAL PROBLEMS[3]

An environmental problem (such as air pollution) has two components: first, the *natural/human environment component* (e.g. toxic substances and the adverse effects they cause in and to certain environments); and second, the *institutional environment component*, the various interests affecting, acting upon and affected by the problem (e.g. polluters, regulatory agencies, people who are recipients of the pollution, organizations such as insurance companies who are brought in, etc.). No environmental problem can be fully considered without taking account of both components and the relationships between them (e.g., since pollution is perceptual it becomes a matter of definition which raises the question, "Whose definition?").

The basic characteristic of environmental problems can be expressed as a dilemma:



The extent of the dilemma in any particular case depends on (a) the complexity of the problem on the natural/human environment side, and (b) the degree of control on the institutional side.



[3] Elaborated in Lang, Armour and Hughes (1978).

An example of "A" is the construction (in the old days) of a road by a highways department with full control over the necessary resources, land, etc., and with its concerns strictly limited to the right-of-way and the movement of people and goods (i.e. no concern for ecological or social impacts, etc.). Situation "B" is typified by a forest products firm which has the same degree of control as the previous example but has expanded its natural/human environment concerns (e.g. to consider effects on adjoining communities or on forest ecosystems). Quadrant "C" is the circumstance typically encountered by linear facilities, such as hydro transmission corridors which cut across numerous jurisdictions and narrowly restrict themselves to the business of providing their service. The last quadrant, "D", is commonly encountered by a municipality which defines its environmental concerns widely but has severely limited powers to act on these concerns.

Focusing exclusively on the environmental side (the tendency of natural scientists), where a holistic perspective is essential to *understand* how environmental systems work, tempts one to offer an equally all-embracing prescription for *directing* and *controlling* the environment in question (e.g., a comprehensive information base, policy, plan, organizational structure). Management experience and the literature of planning and administration clearly demonstrate the infeasibility of this naive approach to governance (Etzioni, 1968; Friedmann, 1971; Dunn, 1971; Friend et al, 1974). Diverse values cannot be integrated into a single normative scheme aimed at a 'public interest'; given the high degree of uncertainty common to most environmental situations.[4] Agencies lack the knowledge, skills and information to prepare such plans adequately and the degree of central coordination needed to implement comprehensive plans seldom exists, mainly because the key forces are ouside the implementing agency's control. The logic of comprehensiveness is inconsistent with the imperatives for action while comprehensive plans focus on commitment on a wide range of overall goals

[4] Hickling (1975) identifies three main types of uncertainty and the conventional responses to each: uncertainty about the operating environment (we need more research, data, surveys); uncertainty about values, about what people want and what organizations should aim for (we need more policy guidance); and uncertainty about choices in related areas of decision, about what other actors will do (we need better coordination, we have to take a broader view).

for long-term gain. The realities of organizations and politics demand flexibility of response with a narrow range of objectives for short-term gain. It is not surprising, therefore, that comprehensive plans have fared poorly especially in circumstances of high uncertainty and minimal control.

But that has not stopped the comprehensive approach from being prescribed. In fact, as House (1976) shows, in fields such as area-wide water planning and management in the United States, health services, recreation, and residuals management, comprehensive planning is on the upswing. In part, that is because the approach, which Fagin (1967) has neatly summarized, has much appeal:

> "A major objective is to introduce at every level and in every function a sense of time flow, a perception of the detail in the context of the larger whole, an awareness of the integrity of each subsystem at the same time as a recognition of the functioning of the larger system as a whole."

Comprehensiveness[5] also looks good when we consider the other extreme, one form of which has been labeled "disjointed incrementalism" (Lindblom, 1959). When the 'realities' of the institutional setting are taken as given, innovation is stifled and the ad hoc results are often unsatisfactory — narrowly defined, short-range and fundamentally destructive to continued functioning of environmental systems.

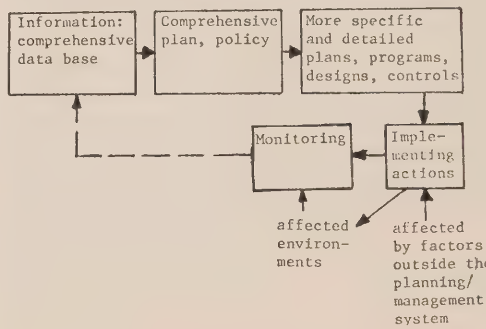
Both comprehensiveness and disjointed incrementalism, reacting to each other, are appropriate in certain circumstances. Neither, however, is a panacea. That means we must be able to diagnose problems and their institutional contexts, and prescribe accordingly without being dogmatic about it.

[5] "Comprehensive", of course, has various definitions. For instance, it can mean "all-encompassing", that is, one is more comprehensive if one gathers more data, analyzes more variables, includes more functions in the plan. Alternately, it can mean "holistic", that is seeing wholes rather than merely parts, which in turn mean identifying the key parts and their relationships which cause them to form and function as a whole. The latter view offers the opportunity to be selective in identifying the few *key* components and relationships essential to defining the whole.

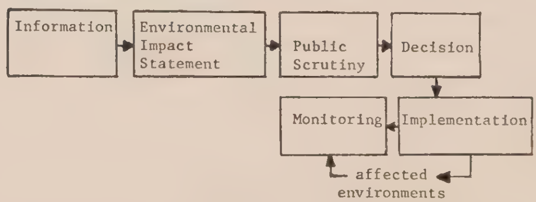
AN ALTERNATIVE MANAGEMENT RESPONSE

Effective coping with environmental problems requires comprehensive understanding and analysis, and it requires integrated action among the key actors in consultation with affected interests. How to achieve such comprehensiveness and integration, appropriate to the circumstances, is the problem.

"Appropriate to the circumstances" is the key. In Quadrant A of the previous diagram, where the implementing agency has defined the problem as simple (or reduced it to that level) and possesses sufficient power to ensure that all necessary actions will be taken, a fully comprehensive approach makes sense. Blueprints for buildings and critical-path schedules for major construction projects come to mind. Different approaches are needed for Quadrants B, C and D. The conventional ends-to-means planning style (shown below), and the role of information in planning/management, become increasingly inappropriate.



Note that the first three activity blocks only occasionally are carried out by the same group or agency (and that monitoring is hardly ever done). More often, they are shared among groups/agencies. The information specialist's job typically ends with his data input; that tends to minimize his identity with and sense of responsibility to the larger process, as well as accountability for the data and its subsequent value. The data person's role is similarly front-end-oriented and limited in environmental assessment processes:



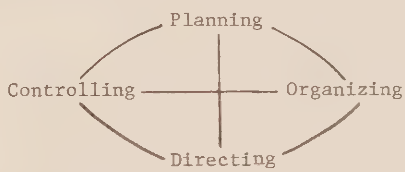
The sequential large-scale comprehensive planning approach may be adaptable to Quadrant B circumstances, depending on the complexity of the environmental problem. Quadrant C and D problems, on the other hand, require more than the usual plan; also needed are implementation strategies worked out among the various agencies and interests affecting and affected by the planned action.[6] Comprehensive plans can seldom be imposed on others, and it is a rare plan whose logic is so compelling that other actors will follow it voluntarily. Benveniste (1972), however, demonstrates that other means are available to achieve integrated action via planning (the "multiplier effect", for example, where a plan is influential because various decision makers and implementing agencies, believing it will be adopted, reorient their actions accordingly). And new approaches such as environmental mediation (Baur, 1977; Rivkin, 1977), together with the familiar experience of political horse-trading, remind us that there are various ways to achieve integrated action, if we are sufficiently open-minded and imaginative to attempt them.

In environmental planning for Quadrant C and D situations, it makes sense to limit the holistic approach to *selected*, closely related environmental functions and agencies. Instead of a single comprehensive data base or plan, we have to proceed with a diversity of initiatives that exploit opportunities as they arise, working gradually towards more integrated environmental management. Rather than beginning by assembling a comprehensive data base, formulating a set of overall goals and preparing an all-encompassing plan, we are more likely to begin wherever we can (e.g., starting small by attempting to improve the data or direction that guides a specific action). Such interventions will be more effective if they are designed as building blocks, capable of adding to and reinforcing each other within a larger framework.

In other words, just as the planner, facing complex multi-interest environmental problems, must widen his repertoire of approaches, so also must the information specialist. Information inputs to the planning/management responses to such problems cannot be limited exclusively to the front end of environmental planning or evaluation, lest they end up being the wrong kind of information received too late to inform decisions. That does not necessarily detract from a holistic approach to ecological data classification. But it *does* indicate that the data needs of user-planners and user-managers change from Quadrant A through to D. The former may require a total data base; the latter is more likely to demand various discrete bits of data focusing on specific resources and interrelationships in response to defined problems. Also, in the latter it is much more important to connect with the user. If only your professional judgement determines the data collected, you could miss the user's needs by a wide margin.

Opportunities to diversify data and planning inputs present themselves at two levels, horizontal and vertical, reflecting the way management processes work.

The *horizontal* opportunity is revealed by the classical model of management (Koontz and O'Donnell, 1968):



Planning, a central function of any management process, involves formulating objectives to achieve goals in line with available resources and devising and selecting among alternate courses of action. Planning goes on at various levels throughout any organization (described below under "vertical").

Organizing involves grouping activities, establishing authority relationships and

[6] Sometimes a Quadrant C or D situation can be reduced to a more manageable Quadrant B. I have the impression that the Societé de developpement de la Baie James has done just that. Faced with massive uncertainty on both the external environment and institutional sides, the planners began by negotiating on the latter (native land claims) and acquiring the powers of a municipality within the (huge) planning area. Result: institutional complexity was reduced considerably thereby allowing the natural/human environment aspects of the problem to be defined as complex and a sophisticated environmental planning process to be launched. The point demonstrated is that both kinds of complexity can't be handled at once but sometimes they can be dealt with separately in sequence. Beginning with reduction of institutional complexity through inter-interest negotiation may be the more appropriate strategy generally.

providing necessary coordination to carry out plans and achieve goals.

Directing involves providing leadership and guidance, motivating people, maintaining communication and ensuring accountability.

Controlling involves evaluating accomplishments against plans, and correcting performance and plans accordingly.

For example, at the municipal level:

Planning	Organizing	Directing	Controlling
Env. data base	Env. advisory committee	Political will, commitment	Env. assessment
Env. policies	Env. coordinator	Env. accountability	Env. review processes
Env. land use plan	Interdep. coordination	Public education	Monitoring, feedback
Env. oriented functional plans	Relating env. assessment to planning	Relate to other agencies, interests	Public info. Capacity-related dev. controls

Opportunities in the *vertical* dimension reflect the three levels of planning in an organization (Anthony, 1965):

Strategic level: concern with ends, with goals and policies, and with availability and use of resources needed to achieve the goals. Responsibility of a municipal council, board of directors, etc.

Operational level: the other extreme, concerned with means, with assuring that specific tasks are carried out efficiently and effectively. Responsibility of supervisors.

Administrative level: linking strategic and operational levels. Responsibility of senior managers.

It is insufficient to build environmental considerations into the strategic level only (which is what comprehensive plans favour). Strategic planning merely leads to further planning at the next level which guides yet another level until the final implementing actions occur. Environmental considerations, plus a close continuing watch over what actually happens (with disincentives), must be built into *each* level. Environmental resources are often lost through actions at the final stage in a sequence of plans.[7] Comparable "activity-sequence planning" is needed to trace, from the top, goals and policies down through the various levels to the environments affected, and to do the same from the bottom beginning with environments of concern, identifying/analyzing all activities that may degrade these environments and working to build environmental considerations into all planning that guides such activities.

The foregoing horizontal-vertical model of management can be misleading, however. For one thing, everyday experience tells us that numerous organizations, public and private, affecting the environment are poorly managed — inadequately planned, organized, directed, controlled. Furthermore, much of any environment is not subject to *any* kind of management; it falls between or outside the mandate of existing organizations (long-range transport of air pollutants is an example). These two observations ought to warn us that environmental planning and management — terms easily thrown around as though to say it was to do it — are not merely a matter of bending existing planning and management processes in an environmental direction, say by feeding-in better ecological data.

For that reason critical ingredients of an environmental management framework are *pre-action evaluation* (e.g., environmental impact assessment) and *environmental monitoring-feedback*. The best hedge against uncertainty is to keep an eye on affected environments, note changes and effects irrespective of causes, and trigger corrective action as needed. As results from monitoring enlarge the data base for planning, the capacity to take *preventive* action (which is what environmental management is all about)

---

[7] An example from Toronto, of what can happen otherwise: A bulldozer operator, in a morning's work, destroyed a valued gull nesting ground on the Toronto Islands, despite the existence of a high-powered (but high-level) environmental planning program that involved senior members of his department. It cannot merely be assumed that environmental concern at the top will filter down on its own. As much attention to environmental quality is needed at the 'bottom' (in the field) as at the 'top' (in the office); in fact, the top/bottom hierarchial model itself can be part of the problem.

should grow. Of course, pre-action evaluation and monitoring offer significant additional opportunities to those concerned with improving environmental data inputs. Equally, there are plenty of barriers to bringing them into effect (especially the threat to organizations and careers that is involved when monitoring reveals what appear to be errors and omissions).

Amidst this heady talk of opportunities we should remain carefully modest about what environmental data and planning can be expected to do, at least as long as they are approached as technical rather than political processes. For as Eckholm notes, with reference to developing countries but applicable to Canada too (Goldsmith, 1977):

> "Land use patterns are an expression of deep political, economic and cultural structures; they do not change overnight when an ecologist or forester sounds the alarm that a country is losing its resource base. In many countries the deterioration of land will not be halted until basic changes in land tenure and national economic priorities occur."

SUMMARY

1. Professionals engaged in assembling environmental data and in environmental planning share a concern that the results of their work may not be influential with respect to the environments that concern them. A solution may be to organize and conduct data gathering and planning within the context of the management processes they serve.

2. The basic purpose of environmental planning is to guide human activity toward enhancement of environmental capacity and quality. Capacity and quality are closely related to each other and to management decisions affecting given environments.

3. The basic feature/dilemma of environmental problems is that while environmental systems function in an interrelated holistic manner, the institutional systems that are supposed to deal with environmental problems tend to function in a disjointed separated manner. This is less so when the environmental problem is narrowly focused and well understood, and when the implementing agency can ensure that the required actions will be taken. In such circumstances, holistic prescriptions (comprehensive date bases, plans, organizational structures, etc.) are appropriate. But where problems are defined as complex and where multi-jurisdictional action is required, the holistic approach which seems to make sense in terms of understanding the *natural/human environment* component of the problem, will be inappropriate for the *institutional* component (nonetheless, the holistic or comprehensive approach, exceedingly tempting, is often prescribed). A more appropriate response involves selectively gathering data, planning and linking various implementing actions, at first on a limited scale, but gradually widened as knowledge of environmental problems grows and the organizational capability (as well as willingness) to deal with them increases.

4. For both environmental data specialists and planners, two conclusions follow: (a) the more complex the environmental problem and the more agencies involved in implementation, the more attention you must give to the needs of the users of data/plans and those affected by them, and the less applicable will be the all-encompassing, sequential, ends-to-means approach which requires less consultation; and (b) such circumstances call for a *diversity* of data and planning inputs.

5. Opportunities to diversify these inputs arise in two dimensions in any organization: *horizontal* (in the planning, organizing, directing and controlling of its activities); and *vertical*(at strategic, administrative and operational levels in the organization). An effective set of environmental interventions must include both dimensions. Diversifying data and planning inputs is most likely to succeed if a *building block* approach is used, allowing discrete initiatives to proceed incrementally but designing them to fit together eventually within an integrated environmental management framework.

What has been presented here is more a direction than a solution. It switches emphasis from how to collect and organize data and prepare plans to what are the data and plans for. It departs from the standard information-planning-implementation sequence and instead suggests creating numerous sockets in which to plug data and planning advice, *throughout* various planning and management processes that affect environments of concern. It redefines the problem of "How can we create comprehensive data bases and plans" to "How can we best match our data and planning approaches to the *kinds* of environmental problems we face and the *kinds* of management processes our work serves.

"Kinds" is emphasized because I do not suggest that you limit your work to specific data which planners and managers say they require. A professional responsibility, as always, is to diagnose as well as to prescribe, and to give the client what you think he needs, not just what he says he wants.

REFERENCES

Anthony, R.N. 1965. Planning and Control Systems: A Framework for Analysis. Harvard University, School of Business Administration, Boston. 180 p.

Baur, E.J. 1977. Mediating Environmental Disputes. Western Sociological Review 8(1): 16-24.

Bishop, A.B. et al 1974. Carrying Capacity in Regional Environmental Management. U.S. Environmental Protection Agency, Washington. 170 p.

Dunn, E.S., Jr. 1971. Economic and Social Development: A Process of Social Learning. Johns Hopkins Press, Baltimore. 327 p.

Eckholm, E.P. 1976. Losing Ground: Environmental Stress and World Food Prospects. W.W. Norton Co., New York. 223 p.

Etzioni, A. 1968. The Active Society: A Theory of Societal and Political Processes. Free Press, New York. 698 p.

Fagin, H. 1967. The Evolving Philosophy of Urban Planning. pp. 309-328 *in* Urban Research and Policy Planning (ed. by L.F. Schnore and H. Fagin). Sage Publications, Beverly Hills, Calif.

Friedmann, J. 1971. The Future of Comprehensive Planning: A Critique. Public Administration Review 31(3):316-326.

Friend, J.K., J.M. Power and C.J.L. Yewlett. 1974. Public Planning: The Inter-Corporate Dimension. Tavistock Publications, London. 534 p.

Godschalk, D.R. and F.H. Parker. 1975. Carrying Capacity: A Key to Environmental Planning? Journal of Soil and Water Conservation, July-August: 160-165.

Goldsmith, E. 1977. The Future of an Affluent Society: The Case of Canada. The Ecologist 7(5):160-194.

Hickling, A. 1975. Aids to Strategic Choice. University of British Columbia, Centre for Continuing Education Vancouver. 64 p.

Hill, A.R. 1975. Ecosystem Stability in Relation to Stress Caused by Human Activities. Canadian Geographer 19(3):206-220.

Holling, C.S. and M.A. Goldberg. 1971. Ecology and Planning. J. Amer. Institute of Planners 37(4):221-230.

House, P. 1976. The Quest for Completeness: Comprehensive Analysis in Environmental Management and Planning. Lexington Books, D.C. Heath and Co., Toronto. 245 p.

Koontz, H., and C. O'Donnell. 1968. Principles of Management. Fourth edition. McGraw-Hill Book Co., New York. 822 p.

Lang, R. and A. Armour. 1976. Municipal Planning and the Natural Environment. Planning Act Review Committee, Ontario Ministry of Housing. Toronto. 90 p.

Lang, R. and A. Armour. 1977. Oakville Environmental Report: A Case Study in Environmental Planning. Lang Armour Associates, Toronto. 181 p.

Lang, R., A. Armour and W. Hughes. 1978. Environmental Planning Resourcebook 1. Environment Canada, Lands Directorate, Ottawa.

Lindblom, C.E. 1959. The Science of "Muddling Through". Public Admin. Review 19:79-99.

Medford, D. 1973. Environmental Harrassment or Technology Assessment? Elsevier Scientific Publishing Co. Amsterdam.

Rivkin, M.D. 1977. Negotiated Development: A Breakthrough in Environmental Controversies. Conservation Foundation, Washington. 23 p.

Rodgers, G.K. 1975. Recreation in Natural Environments. York University, Faculty of Environmental Studies, Downsview. Unpublished paper. 116 p.

Schwarz, C.F., E.C. Thor and G.H. Elsner. 1976. Wildland Planning Glossary. U.S. Dept. of Agriculture, Forest Service. Washington. 252 p.

Wiken, E.B. 1979. Ecologically Based Planning: A Report on the CCELC Urban Workshop *in* Proc. 2nd Meeting Can. Comm. Ecol. Land Classif. (comp. and ed. by C.D. Rubec). Ecol. Land Classif. Series No. 7. Lands Directorate, Environment Canada, Ottawa.

THE APPLICATION OF ECOLOGICAL LAND CLASSIFICATION FOR THE SITING OF PORT LABRADOR*

N. Lopoukhine and H. Hirvonen
Lands Directorate
Atlantic Region
Environment Canada
Halifax, Nova Scotia

INTRODUCTION

In order to properly determine potential effects of development on the natural resources of Labrador, the Newfoundland Department of Forestry and Agriculture along with the Lands Directorate perceived the need for pertinent baseline data for all of Labrador. An ecological land classification (ELC) of Labrador was undertaken specifically to bring under one cover and on one map, at a reconnaissance level (scale 1:1,000,000) a description and depiction of Labrador's varied landscapes and their inherent resources (Lopoukhine et al, 1978). This classification based principally on the visual interpretation of satellite imagery concentrated on the determination and description of Land Regions and Land Districts. With this background, critical areas in terms of environmental sensitivity may be pinpointed within Labrador. As well, proposed developments may be measured, on a gross scale, for environmental compatibility. Accordingly, future monies and manpower may be concentrated on the detailed study of these more critical areas to ensure an adequate data base upon which various projects may be assessed.

Of current interest to the Newfoundland government is the siting and development of port and related facilities. Such a development is part of one method being considered for bringing ashore potential oil and gas reserves off the Labrador coast. The environmental implications of such development to coastal waters and adjacent lands may be substantial. The application of ecological land classification principles to any proposed port site and surrounding area aids in the identification of potential environmental hazards and serves as a basis for an environmental impact assessment of the total development.

This paper concerns itself with the application of ecological land classification to an area encompassing Rigolet, Labrador (Figure 1). Long Point, located northeast of Rigolet at the head of Groswater Bay, has been identified as a potential site for Port Labrador. The total study area covers some 12,700 sq km. Land Systems were mapped at a scale of 1:125,000 and various interpretive maps were derived from the analysis of these systems.

Figure 1: Location of Study Area

In addition to demonstrating the application of ELC principles to project planning, this project was designed to check the accuracy of the previous reconnaissance mapping for the study area completed from the analysis of satellite imagery (scale of 1:1,000,000) and to gain field experience in the analysis of land/water components of the coastal zone and inland as input to the CCELC Land/Water Integration Working Group.

STUDY AREA

The choice of Long Point as a site for Port Labrador was based principally on suitable bathymetry (6 fathoms at 240m from shore) and minimal offshore ice buildup in the area. Other features which characterize this part of Labrador are a climate defined by a mean annual temperature of $0^{o}C$, an annual mean precipitation of 800mm and an annual mean snowfall of between 400-500 cm (Peach, 1975). The winter usually

*Abstract/Résumé on/à page 301.

arrives in late October and lasts into early June. The Labrador Sea within this study area usually freezes in early November and breakup occurs in mid May. In Cartwright Harbour, south of the study area, the freeze-up normally occurs in mid December and the first deterioration is expected in early May. Satellite imagery of 9 December 1973 and 27 March 1974 shows open water throughout Groswater Bay (Prout, 1977).

Physiography consists of a combination of mountainous plateau, and low lying areas. The land bordering Groswater Bay and the northern coast of the study area is characterized by numerous strand lines and fine marine lain deposits. The latter are often covered by organic deposits with pronounced palsa bog formation. The plateau area is inland of the coastal lands and is characterized by drumlinized and blanket morainal material interspersed with glaciofluvial deposits.

Vegetation is principally transitional from boreal forest to tundra. Examples of boreal forest occur along the inner reaches of Groswater Bay and the Backway as well as near the north shore of the study area. The tundra-like vegetation occurs along the northeast coast and within the confines of the Benedict Mountain area.

Precipitous rock and shallow mud flats depict much of the coast line. In the latter areas boulder barriers which are considered to be a result of a freezing and thawing process in the shallows of protected bays are common. Within Groswater Bay there are no large sand beaches. Beaches do occur at the mouth of Micheals River and in Byron Bay. These beaches are backed by extensive dune systems. Numerous cobble and shingle beaches are present throughout the shore line.

Currents are very much in evidence in this part of the Labrador coast. The channel leading into Lake Melville has had currents recorded of up to 5.5 knots. This current and an upwelling in Groswater Bay is the cause of longer than average ice-free conditons and a rich avifauna population.

METHODOLOGY

The survey was conducted by a seven-man crew consisting of a plant ecologist from the Canadian Forestry Service, St. John's, two land classifiers and a technician from the Lands Directorate, Halifax, one technician from the Lands Branch of the Newfoundland Department of Forestry and Agriculture and two summer students. Field operations spanned the month of August and were centered from the coastal community of Rigolet.

Prior to initiation of field work tentative Ecological Land System units were delineated on 1968 1:50,000 black and white air photos. Available ELC physiographic, climatic and glacial historical data were referenced before and during this procedure. In particular, reconnaissance landform mapping of part of the study area under the direction of R.J. Fulton (1969) proved an invaluable aid. Tentative air calls and ground checks were plotted on a master map of the area to ensure that as much as possible of the varying terrain would be covered. Proposed ground transects were plotted to cover some of the more diverse and interesting terrain. Tally sheets were devised to ensure uniformity of data collection for both air calls and ground checks.

During field operations the team was divided into two crews for survey purposes. A Jet Ranger Model A was used to shuttle the crews alternately throughout the survey area. Air calls were conducted over as many Land Systems as feasible. Data noted includes vegetation characteristics, landforms, drainage conditions and general topography. As well, any distinctive erosional patterns, palsas, slumps and geological formations were described. Water characteristics were not sampled but the water features interpreted on aerial photos were verified.

Ground checks and transects concentrated on detailed description of landforms, soils, vegetation and other physical site parameters. Particular attention was paid to the distribution of palsas. Along the coast, the extent of salt marsh, occurrence of strand lines, terraces and other marine features were given emphasis. A coastal geomorphologist from the Bedford Institute of Oceanography was engaged with the field operations for one week to map coastal features around the Rigolet area.

The field data collected was systematically analyzed. Based on field samples, a plant association table was drawn up, successional patterns were determined and the range of land characteristics per Land System was elucidated. Also, field samples were used to verify the preliminary photo interpretation and to identify those areas requiring revision. A final classification was developed based in part on the field samples. Aerial photographs for the study area were reinterpreted accordingly.

The details of each Land System were transferred from aerial photographs onto a base map and a final chronoflex prepared. A copy of the legend

utilized is given in Table 1. Topography, drainage, landform and water features characterizing each Land System are noted on the map.

The methodology followed in comparing results of Regional delineation and in the application for ELC data appears below under the respective headings of "Comparison" and "Applications".

COMPARISON

One of the objectives of this study was to arrived at a comparison between the ELC of this conventional approach to the 1:1,000,000 Regional and District ELC published previously. In the compilation of the 1:1,000,000 map it was quite evident and stated in the accompanying report that satellite imagery has certain advantages as well as limitations for ELC mapping. On this basis it was foreseen that revision of Region boundaries would occur as more detail became available. This study provided the opportunity to ascertain the accuracy and to redefine, where necessary, a more precise boundary for individual Regions occurring in Labrador. Figures 2 and 3 respectively show the boundaries of the Regions as depicted on the 1:1,000,000 map and those boundaries arrived at by this study.

The method of determining Regional boundaries in this study involved the mapping of provisional Land Systems at a scale of 1:125,000. Based on these Systems a sampling stratification was determined to investigate the major vegetational changes within the area. During the mapping of the final Land Systems vegetative patterns on aerial photography were correlated to the field data.

The same number of Land Regions with similar characteristics as identified on the 1:1,000,000 map are recognized by this study but with some modifications to boundaries. In particular, Region N, the Benedict Mountains, is reduced in size while Region O's boundary is moved considerably to the north. Region W was extended to the west along the south shore of Groswater Bay and no longer borders on the Backway. Region L has been reduced in the southeast and Region T is extended more to the east than originally delineated on the 1:1,000,000 map. Not all boundaries were shifted. Of particular note is the boundary between Regions O and T. Furthermore, outliers of adjoining regions which could not be mapped at a scale of 1:1,000,000 became discernable at the scale of 1:125,000.

Based on this study it appears that satellite imagery and the methodology utilized in the

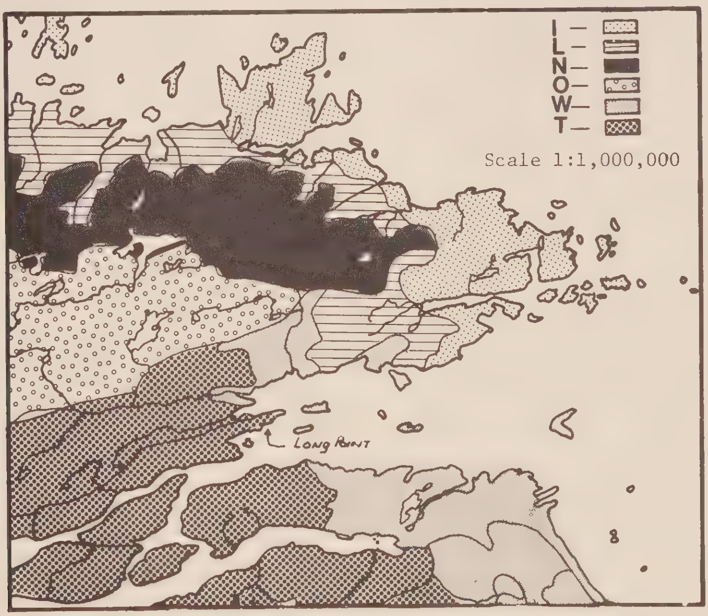
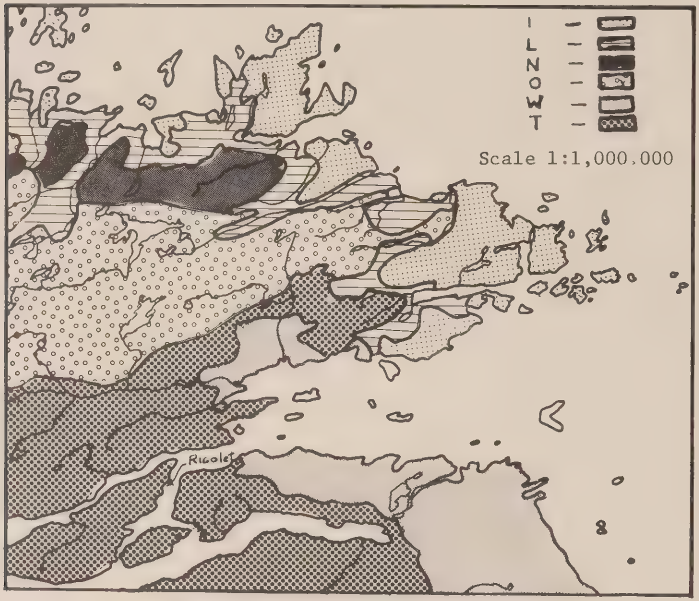


Figure 2: The study area with the Land Region boundaries as depicted on the 1:1,000,000 map interpreted from LANDSAT imagery (Lopoukhine, Prout and Hirvonen, 1977).

Figure 3: Newly defined boundaries of Land Regions within study area based on data gathered in this study.



production of the 1:1,000,000 map is a valid means of differentiating Land Regions given the associated costs and time involved. Accuracy suffers most in areas where biophysical changes are gradual. District boundaries within the various Regions have, for the most part, remained the same as depicted on the 1:1,000,000 map. The only exception would be that Land Districts 8 and 9 of Region L should be merged due to their physiographic similarities.

APPLICATIONS

The area immediate to the proposed site of Port Labrador was chosen to depict various interpretive applications of ELC data for engineering purposes.

Four classes of capability of erosion hazard, trafficability and availability of borrow material were developed and each Land System was rated based on a subjective evaluation of its characteristics (Figure 4).

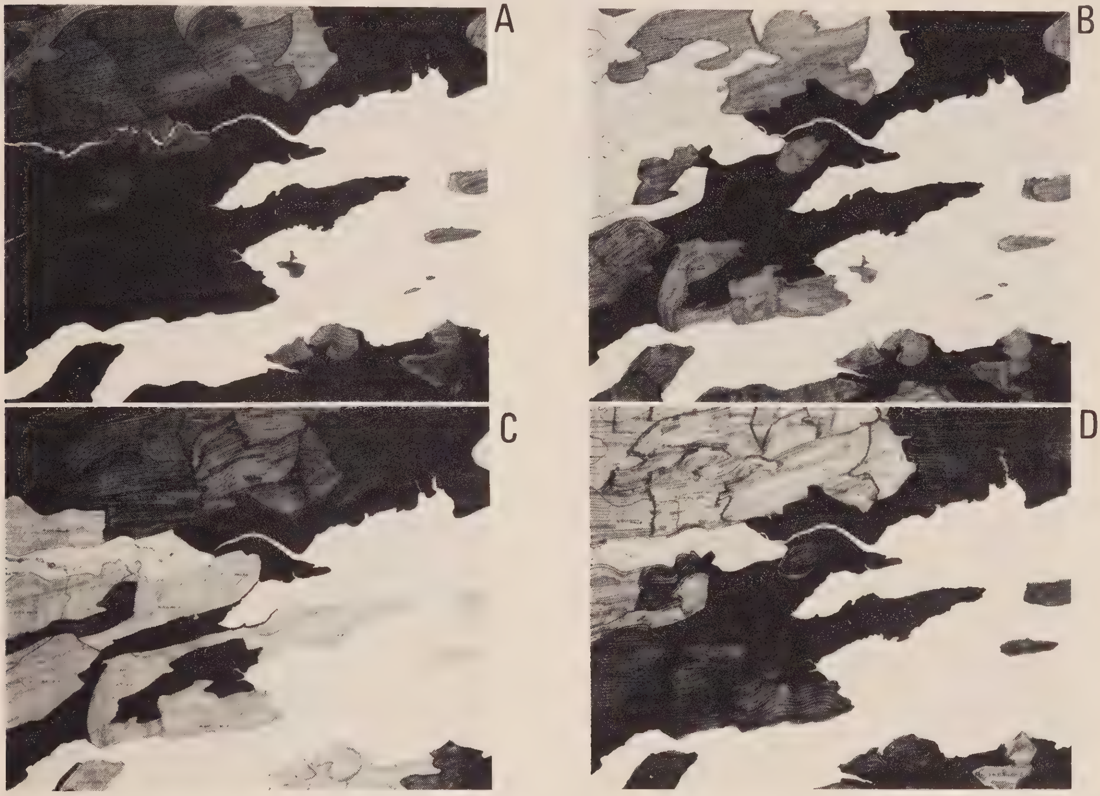
The erosion hazard risk (Figure 4A) rates each Land System's susceptibility to erosion after removal of vegetative cover, either through burning, harvesting or construction. Topography, genetic material, and surface expression are the factors used in the development of these ratings. For instance, in mountainous terrain covered with a veneer of till the erosion risk would be high. Similarly, a high risk occurs in areas that are flat but composed of fine textured, marine lain deposits.

Trafficability ratings (Figure 4B) depict ease of maneuverability of machinery associated with major construction developments. Topography, drainage, genetic nature of the surface materials and water features are used to determine these ratings. The most difficult areas for large machinery to operate in are mountainous terrain, flat but organic and/or permafrost terrain or terrain with numerous small streams resulting from poor drainage.

The third map (Figure 4C) is an illustration of the availability of construction materials within each of the Land Systems. The best Systems are characterized by glaciofluvial material or thick, rapidly drained, morainal material. Poorly rated Land Systems are those that have a dominance of organic or marine lain deposits.

The fourth map (Figure 4D) is a combination of these three maps giving a quick reference to the area's opportunities and constraints relative to engineering. The lightest grey represents areas with minimal engineering constraints. In contrast, the darkest tones outline areas with considerable engineering problems.

Figure 4: these four maps represent possible applications of ecological land classification. Map 4A shows erosion hazard risk - darker tones having more severe risk. Map 4B depicts suitability of surficial materials for construction - darker toned areas have more available sand and gravel aggregates. Map 4C indicates trafficability ratings for each Land System - darkest tones in areas with worst conditions for movement of heavy construction vehicles. Map 4D is a composite indicating opportunities and constraints in the immediate Long Point area for engineering with the darkest areas presenting the most significant problems for construction.



From interpretations derived from Figure 4 it is possible to assess the general suitability of Long Point for Port Labrador. Although on the basis of bathymetry and ice conditions the site is a good one, there are a number of engineering constraints to port development. An analysis of general site conditions indicate that the parent material consists largely of silts and clays with cappings of sandy, gravelly beach ridges in places. Both bogs and exposed bedrock are common. Several palsa bogs also occur.

Thus suitable construction material in the immediate vicinity of the proposed site is minimal. The profusion of marine silts and clays and bogs indicate potentially high risk of erosion and severe trafficability problems. The lack of lakes and streams within this Land System may lead to problems of freshwater availability although no detailed studies of potential groundwater reservoirs were carried out. The presence of bedrock close to the surface in many places would substantially increase the costs of any excavation or road layout.

The above interpretations are not intended to negate construction of port facilities near Rigolet but more so to identify the hazards and constraints to such construction activity. With the utilization of ELC data as base information planners can compare and evaluate other potential sites in a similar manner. With this evaluation along with the necessary input of pertinent social and economic data the most suitable location and subsequent transportation corridor may be chosen.

CONCLUSIONS

The preceeding interpretations were restricted to engineering considerations associated with the development of Port Labrador. Other applications and interpretations of ELC data have

Table 1: Ecological Land System Legend

Topography (after Jurdant et al, 1977)

M - Mountainous
H - Hilly
R - Rolling
U - Undulating
F - Flat

Origin of Surficial Material and Surface Expression

C - Colluvium	f - fan
R - Bedrock	h - hummocky
F - Glaciofluvial	b - blanket
M - Moraine	r - ridged
W - Marine	t - terraced
O - Organic	s - steep
L - Lacustrine	v - veneer
A - Alluvium	e - eroded
	c - channeled
	d - drumlinoid
	x - complex

To indicate abundance of each Land System component, the following conventions are utilized (after Fulton, 1969).

= equal proportions
/ preceding component more abundant
// preceding component much more abundant

Moisture Regime

1 - excessive drainage
2 - rapid drainage
3 - good drainage
4 - imperfect drainage
5 - poor drainage
6 - very poor drainage

Vegetation

The following classification was outlined on 1:50,000 air photos but not mapped.

Forested: F1 - Merchantable timber (spruce-fir forest with pockets of white birch)
F2 - Lichen woodland
F3 - Scrub forest

Nonforest: NF1 - Burn
NF2 - Alpine or coastal tundra
NF3 - Littoral (marsh, dunes)
NF4 - Organic (a) fen, (b) bog

Water Classification

Standing: Si - inclusive (enclosed by Land System)
Se - exclusive (bordered by Land System)
Sb - bordering salt water

Offshore Gradient: a - abrupt
m - moderate
s - shallow

Fetch: 1 - more than 5 km
2 - 1-5 km
3 - less than 1 km

Current (interpreted from air photos):
e - evident
t - trace
n - no evidence

Flowing stream size:
F1 - all small
F2 - medium with small
F3 - large dominant stream (such as Luscombe Brook, Michaels River)

Obstruction (rapids or falls noted on 1:50,000 air photos), average per stream per Land System:
a - rare
b - up to 3
c - more than 3

Example of Legend Symbolization

Standing water *(inclusive)*
Origin *(bedrock)*
Surface Expression *(hummocky coll.)*
Drainage *(excessive)*
Topography *(rolling)*

R-1-Gh/R-Sim2n·F1a

Offshore gradient *(moderate)*
Fetch *(1-5 km)*
Currents *(none)*
Flowing Water *(small streams)*
Obstructions *(rare)*

been extensively documented elsewhere (Jurdant et al, 1977). Land capabilities for wildlife, forestry and recreation could be determined when considering potential conflicts of use. With some additional sampling other interpretive information relating to hydrology and sport fishery could be readily attained.

ELC data provide a sound base on which initial evaluations of potential environmental consequences of major projects such as port development could be surmised. Furthermore, these data can be utilized to monitor the project as it develops. Ecological land mapping has a valid role to play in resource management given the lead time to collect the necessary data. Cost savings could be substantial as the project develops.

ACKNOWLEDGEMENT

Mr. Robert Bowlby was party chief for the field operations, provided help in photo interpretation and did most of the preliminary cartography.

REFERENCES

Fulton, R. et al. 1969, 1970. Surficial Geology Maps, Scale 1:50,000, Geol. Surv. Can. Open File No. 181, Dept. Energy, Mines and Resources, Ottawa.

Jurdant, M., D.S. Lacate, S.C. Zoltai, G.G. Runka and R. Wells. 1975. Biophysical Land Classification in Canada, pp. 485-495. Proc. Forest Soils and Forest Land Management. (ed. by B. Bernier and C. Winget). Presse Univ. Laval, Québec.

Jurdant, M., J.L. Belair, V. Gerardin and J.P. Ducruc. 1977. L'Inventaire du Capitale Nature: Methode de classification et cartographique écologique du territoire. Série de la classification écologique du territoire, Numéro 2, Direction Régionale des Terres, Québec.

Lopoukhine, N., N.A. Prout and H. Hirvonen. 1977. The Ecological Land Classification of Labrador. A Reconnaissance. Ecological Land Classification Series No. 4, Lands Directorate, Halifax.

Peach, J.A. 1975. The Tourism and Outdoor Recreation Climate of Newfoundland and Labrador, Project Report No. 20, Atmospheric Env. Ser., Environment Canada, Toronto.

Prout, N.A. 1977. The Mapping of Ecological Land Units of Labrador Utilizing LANDSAT Imagery. Proc. 4th Can. Sym. Remote Sensing. pp. 282-293.

ABSTRACT

The reconnaissance mapping and ecological land classification of Land Regions and Districts within Labrador was completed in 1977 as a prerequisite for more detailed work. The possibility of the development of a port within Groswater Bay in Labrador was used as a focus for Land System mapping. On this basis, Land Regions and Districts were formulated and then compared to those of the reconnaissance mapping.

The Land Systems are applied towards determining the engineering suitability of the sites proposed for port development.

RÉSUMÉ

On a établi en 1977, à titre d'étape préliminaire à des travaux plus détaillés, une carte de reconnaissance du Labrador selon une classification écologique du territoire (régions et districts). Ces travaux visaient la construction éventuelle d'installations portuaires dans la baie Groswater. On a donc relevé les données écologiques des régions et districts, puis on les a comparées avec la carte de reconnaissance.

L'application des systèmes écologiques vise à déterminer si l'emplacement proposé convient à la construction des installations portuaires. (Trad. Éd.)

THE VALUE OF ECOLOGICAL (BIOPHYSICAL) LAND CLASSIFICATION IN LAND USE PLANNING: AN ALBERTA CASE STUDY*

D. O. Luff and P. M. Ojamaa
Resource Evaluation and Planning Division
Alberta Energy and Natural Resources
Edmonton, Alberta

INTRODUCTION

Although decisions concerning the management and allocation of land should be based on a consideration of social, economic and environmental factors, invariably urban and regional planners tend to pay little attention to the ecological (biophysical) components (May, 1977). Lack of consideration for ecological data results from: (1) a paucity of available ecological information in a form relevant to planning issues, (2) planners often have little understanding of biological and physical sciences and (3) politicians find it hard to designate areas for conservation in the face of development pressure (May, 1977). Within Alberta Energy and Natural Resources this trend is changing.

At the request of Public Lands Division of Alberta Energy and Natural Resources, the Resource Evaluation and Planning Division developed an integrated land use management plan for a portion of the Wapiti-Grande Prairie Sand Dunes. The plan will aid Public Lands Division in the assessment of lease applications for differing types of land use in the planning area. As well, the plan will assist the County of Grande Prairie in the appraisal of development permits for the area. Due to the ecological fragility of the Wapiti-Grande Prairie Sand Dunes, a fairly detailed Ecological (Biophysical) Land Classification (ELC) was deemed essential to the creation of a viable integrated management plan.

Located south of the City of Grande Prairie (Figure 1), the planning area is composed of parabolic sand dunes intermixed with organic terrain. Enclosed by private land to the west and north, the Resources Road to the east and the Wapiti River to the south, the Wapiti-Grande Prairie Sand Dunes Planning Area encompasses approximately 18 km^2 (Figure 2). The land is predominantly crown-owned and reserved for recreational purposes. Because of their uniqueness to the region and proximity to Grande Prairie the sand dunes receive a great deal of formal and informal recreational pressure.

THE PLANNING PROCESS

The planning process utilized by the Resource Evaluation and Planning Division is summarized in Figure 3. The process as it related to the Wapiti-Grande Prairie Sand Dunes Planning Area may be described as follows.

Problem Definition

Although Public Lands Division was receiving lease applications for differing land uses in the sand dunes area, they were unable to meaningfully assess those applications because no estimate of the capability of the land to support differing land uses existed. Concomitantly, an integrated land use management plan was not available to guide development of the planning area.

Appointment of Planning Team

The Resource Evaluation and Planning Division is strongly committed to the principle of team planning. This allows those managers who are responsible for implementing plans to be involved in the preparation of the plans. This accomplishes two important tasks. One, it encourages understanding by the managers of concepts considered in the planning process and secondly, it develops a commitment on the part of resource managers to implement a plan in which they have played a strong creative role. The Wapiti-Grande Prairie Sand Dunes planning team was composed of designated representatives from:

a) Public Lands Division, Alberta Energy and Natural Resources
b) Alberta Forest Service, Alberta Energy and Natural Resources
c) County of Grande Prairie No. 1
d) City of Grande Prairie
e) Peace River Regional Planning Commission

* Abstract/Résumé on/à page 317.

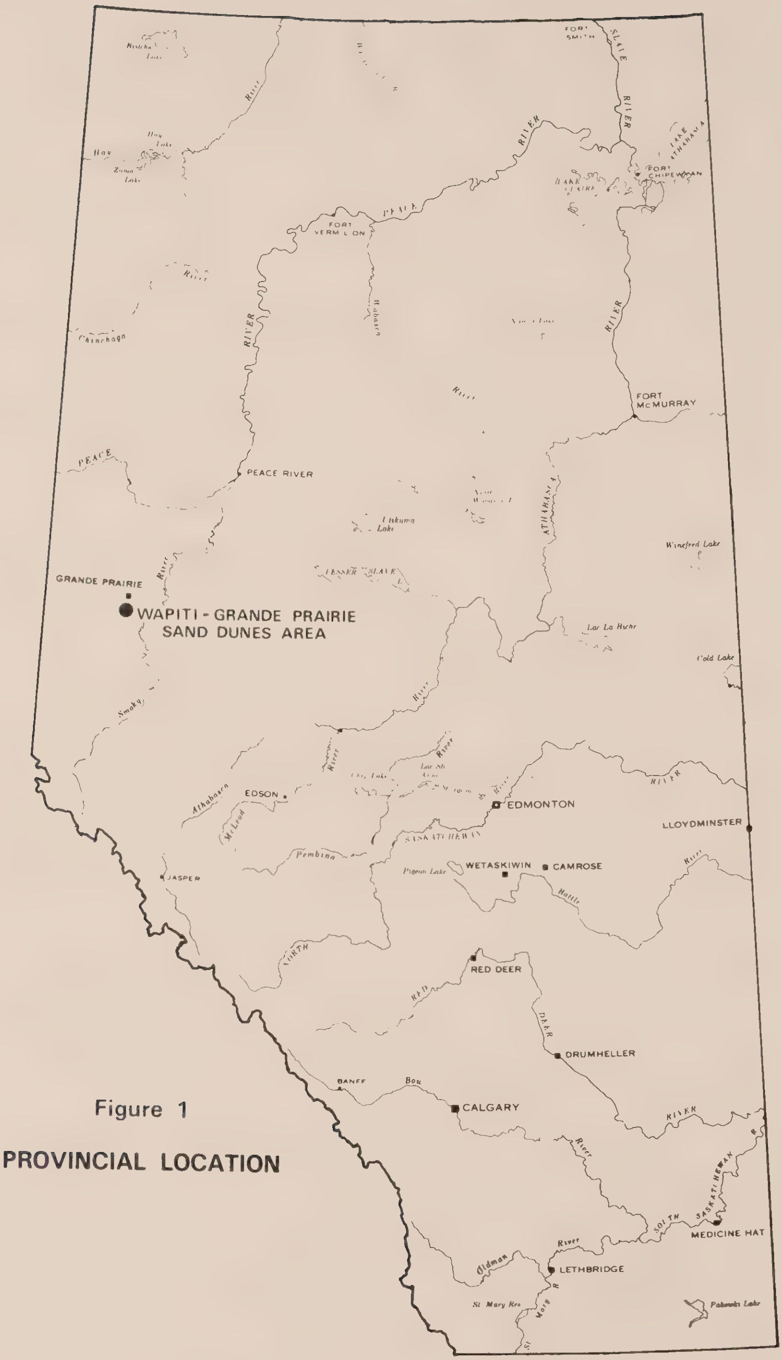


Figure 1: Location of Wapiti-Grande Prairie Sand Dunes Area in Alberta

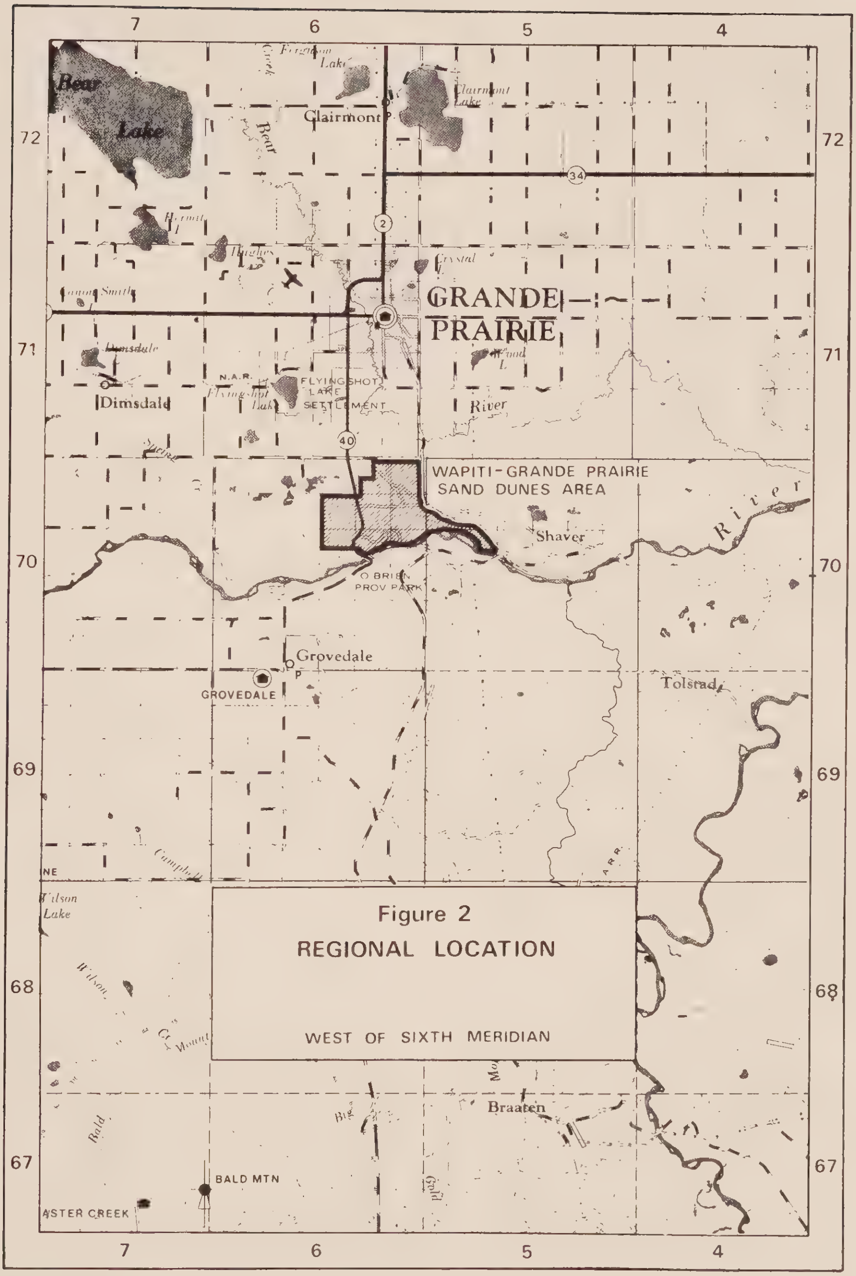
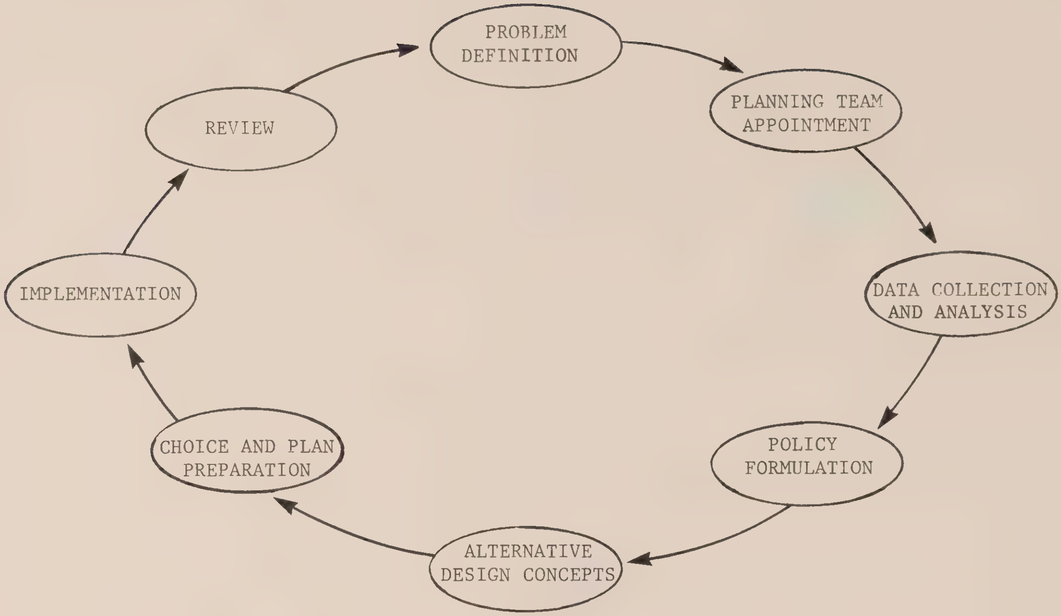


Figure 2: Regional Location of Wapiti-Grande Prairie Sand Dunes Area

Figure 3: The Planning Process



Within the planning process the Resource Evaluation and Planning Division has the role of: a) team leader and coordinator of client needs, b) proposing alternative design concepts and c) preparing the written documents and maps illustrating the agreed upon action. Individual team members have the role of: a) bringing agency concerns to the planning process, b) presenting relevant data supporting agency concerns and c) being committed to achieving an integrated land use management plan that best suits the resources of the area and the needs of the clients. In essence, the Resource Evaluation and Planning Division plays the *consultant* role in the planning process while team members play the *client* role.

Data Collection and Analysis

Data collection and analysis identifies relevant data needs, responsibility of data collection, required mapping scale and precision of data interpretation. It should be noted that although this segment of the planning process is where most of the data is collected and analyzed, all segments may require further data to support them. It is at this stage that ELC data are collected and analyzed by the Resource Appraisal Group of the Resource Evaluation and Planning Division.

Soon after completion of the Ecological (Biophysical) Land Classification, each team member examines the planning area in light of the ELC report and prepares additional data relating to their particular agency interest.

Policy Formulation

Based on the above data and analysis the planning team examines several objectives for the planning area and selects one which is compatible with the Ecological (Biophysical) Land Classification analysis and expressed agency concerns. The selection of one objective for the study area provides the integrated policy framework within which the plan is prepared.

Alternative Design Concepts

Alternative design concepts for the planning area are prepared by the planning team utilizing the aforementioned policy framework. This stage of the planning process is conducted in a meeting format where proposals are presented, evaluated through discussion and accepted or rejected by consensus. The most favoured alternative design is chosen and refined as the integrated land use management plan.

Choice and Plan Preparation

After the most favoured alternative design has been chosen, the Resource Evaluation and Planning Division writes the plan according to team dictates. After review and approval by planning team members, the plan for the Wapiti-Grande Prairie Sand Dunes Area was then presented to the County Council of Grande Prairie No. 1, the City Council of Grande Prairie, the Peace River Regional Planning Commission and the Director of the Resource Planning Branch of the Resource Evaluation and Planning Division. It was at this stage of the planning process that the county and city councils as well as the planning commission solicited formal public involvement in the plan. Once the plan was approved by the concerned agencies as well as the Director of the Resource Planning Branch, the final recommendations were prepared and delivered to the Deputy Minister of Alberta Energy and Natural Resources for his approval.

Implementation

The approved integrated land use management plan will be implemented by Public Lands Division through their assessment of lease applications as well as the County of Grande Prairie through a development control resolution.

Review

A monitoring system has been established to ensure that the spirit of the plan is being implemented. The plan is to be reviewed every 5 years for possible changes in the local situation and in light of any new government policies. Minor conceptual changes can be made by those implementing the plan providing the changes fall within the planned policy framework.

ECOLOGICAL (BIOPHYSICAL) LAND CLASSIFICATION

The Resource Appraisal Group of the Resource Evaluation and Planning Division developed a fairly detailed Ecological (Biophysical) Land Classification for the Wapiti-Grande Prairie Sand Dunes Area at a scale of 1:15,840 (Figure 4). Accompanying the ELC is a use-limitation table (Table 1) that details the severity and types of limitations many common recreational land uses may have in the planning area.

Classification of landscape follows an understanding of the physical characteristics of a planning area. In smaller scale studies conducted by the Resource Appraisal Group (published scale 1:100,000 and smaller) a three tier hierarchical system of classification (S.B.L.C., 1969) encompassing the Land Region, Land District and Land System has been used. Due to the large scale of the present endeavour the fourth tier (Land Type) of the classification system was added. Land region and land district classifications lose their utility in the present study because they are recommended to portray ecological data at scales ranging from 1:3,000,000 to 1:125,000. Thus the ELC for the Wapiti-Grande Prairie Sand Dunes Area narrowed to the following:

a) *Land System:* Land Systems are areas of land having a recurring pattern of slopes, land forms, soils and vegetation. For the present study three land systems were identified: an aeolian plain, organic terrain and a river valley.

b) *Land Type:* Land types are further subdivisions of Land Systems. The land type may be defined as an area of land on a specific parent material having a fairly homogeneous combination of soil (at the soil series level) and vegetation. For the present study relief, pattern of slope and internal drainage were also used to discriminate between differing Land Types.

For the Wapiti-Grande Prairie Sand Dunes Area the scale of the air-photo interpretation (1:15,840) allowed acceptable delineation of individual landforms (parabolic dunes, dune ridges, non-dune plains, etc.) as differing land types. In reality, each landform (land type) is in itself a pattern of quite different slopes reacting to the microclimatic influence of aspect. However, it was felt that dividing landforms into their specific parts would provide too much data for the development of an integrated land use management plan. Consequently, it is these land types that are evaluated in the use-limitation table (Table 1).

Land System and Land Type Descriptions

The following is an abstracted overview of the Land Systems and Land Types identified within the Wapiti-Grande Prairie Sand Dunes Planning Area.

a) *Land System 1 - Aeolian Plain:* The Aeolian Plain Land System encompasses approximately 35 percent of the planning area. The parent material consists of fine to medium wind-blown sand. Soils developed on this sandy parent material are Brunisolic (predominantly Degraded Eutric Brunisols of the Heart Soil Series). These soils are droughty, rapidly drained and have low natural fertility.

Efforts to adequately catalogue the vegetation component of all land systems were hampered

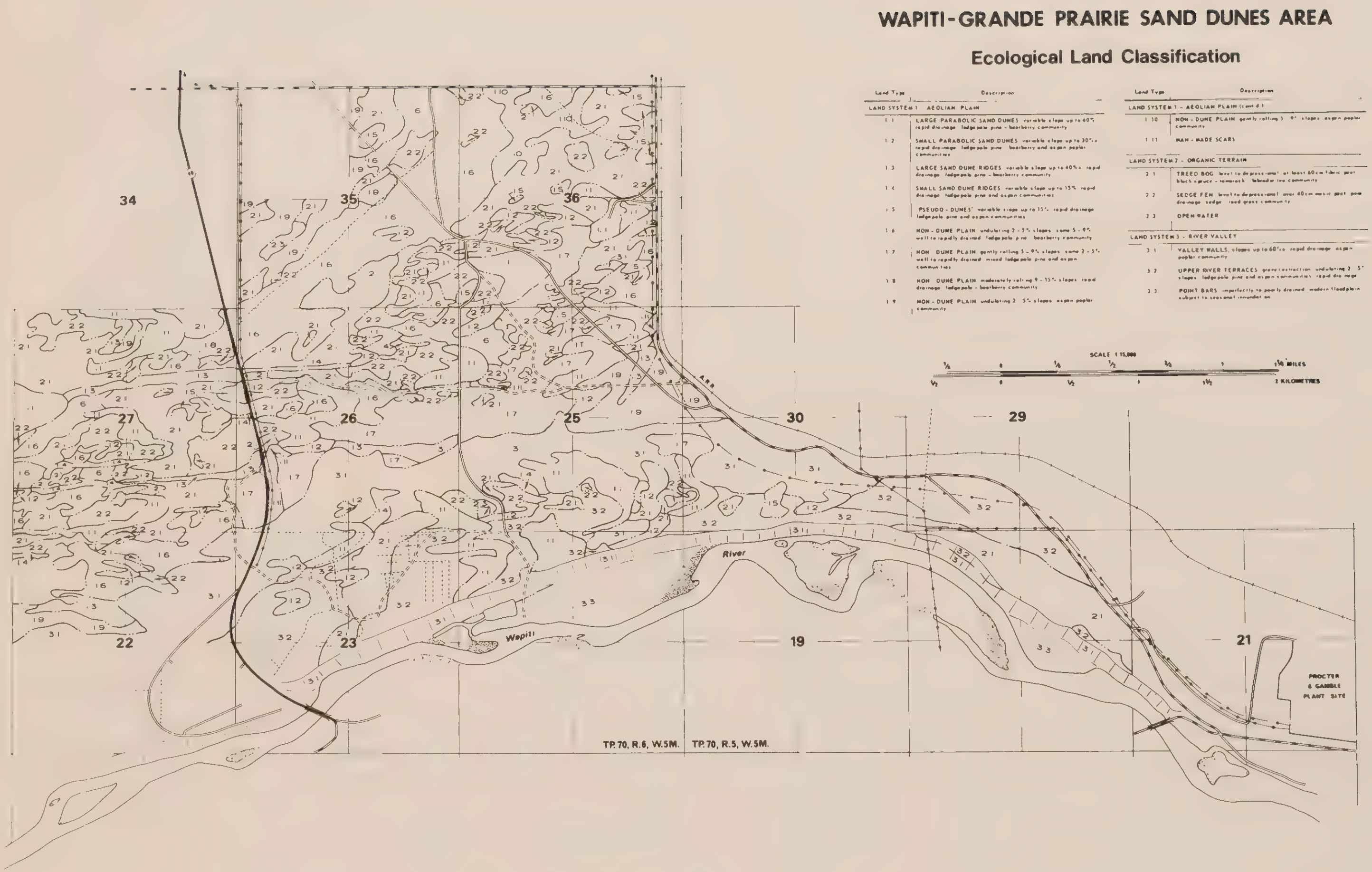


Figure 4: Ecological Land Classification of Wapiti-Grande Prairie Sand Dunes Area, Alberta.

LAND TYPE	DESCRIPTION	DRAINAGE	SLOPE (%)	Bldgs with Basements	Bldgs without Basements	Septic Tank fields	Lawn & Landscaping	Playgrounds	Camp Areas	Picnic Areas	Hiking Trails	Roads & Parking Lots
LAND SYSTEM 1-	AEOLIAN PLAIN											
1.1	Large Parabolic Dunes	Rapid	2-60+	V3	V3	V3, 4, 6	V4, 3, 5, 9	V3, 5	V3, 5	V3, 5	V5	V3
1.2	Small Parabolic Dunes	Rapid	2-25+	M3	S	V3, 4, 6	V4, 3, 5, 9	V3, 5	V5	V5	V5	S
1.3	Large Dune Ridges	Rapid	9-35	V3	V3	V3, 4, 6	V4, 3, 5, 9	V3, 5	V3, 5	V3, 5	V5	V3
1.4	Small Dune Ridges	Rapid	2-15	M3	S	V3, 4, 6	V4, 9, 5	V5, M3	V5	V5	V5	S
1.5	Pseudo-Dunes	Rapid	5-15	M3	S	V3, 4, 6	V4, 9, 5	V5, M3	V5	V5	V5	S
1.6	Non-Dune Plain-Pine	Well to rapidly drained	2-5, some 5-9	S	S	V4, 6	V4, 9, 5	V5	V5	V5	V5	S
1.7	Non-Dune Plain-Poplar & Pine	Well to rapidly drained	5-9, some 2-5	S	S	V4, 6	V4, 9, 5	V5	V5	V5	V5	S
1.8	Non-Dune Plain-Pine	Rapid	9-30	V3	V3	V4, 6, 3	V4, 3, 9, 5	V3, 5	V5	V5	V5	V3
1.9	Non-Dune Plain-Poplar	Well to rapidly drained	2-5, some 5-9	S	S	V4, 6	V4, 9, 5	V5	V5	V5	V5	S
1.10	Non-Dune Plain-Poplar	Well to rapidly drained	5-9	S	S	V4, 6	V4, 9, 5	V5	V5	V5	V5	S
1.11	Man-made Scars	Rapid	2-30	NR	NR	NR	NR	NR	NR	NR	NR	NR
LAND SYSTEM 2-	ORGANIC TERRAIN											
2.1	Treed bog	Very poor	depressional to level	V2, 7, 8	V2, 7, 8	V2, 6	V2	V2, 7	V2, 7	V2, 7	V2	V2
2.2	Sedge fen	Poor to very poor	depressional to level	V2, 7, 8	V2, 7, 8	V2, 6	V2	V2, 7	V2, 7	V2, 7	V2	V2
2.3	Open Water	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
LAND SYSTEM 3-	RIVER VALLEY											
3.1	Valley Walls	Rapid	15-60+	V3	V3	V3, 4	V4, 3, 5, 9	V3, 5	V3, 5	V3, 5	V5	V3
3.2	Upper Terraces	Rapid	2-5, some 5-9	S	S	V3, 6	V4, 9, 5	V5	V5	V5	V5	S
3.3	Point bars	Imperfectly to poorly drained	2-5	V1	V1	V1	V1	V1	V1	V1	V1	V1

S = None to slight M = Moderate V = Severe NR = Not Rated

Table 1: Land Use Limitations for Wapiti-Grande Prairie Sand Dunes Planning Area Land Systems

by the late initiation of the study which resulted in November, 1977 fieldwork. Nonetheless, two significant upland vegetation communities associated with the Aeolian Plain were identified. Firstly, a xeric community composed of an open lodgepole pine (*Pinus contorta*) forest with a ground cover of bearberry (*Arctostaphylos uva-ursi*) was identified. Only occasional aspen poplar (*Populus tremuloides*) and very scattered buffaloberry (*Shepherdia canadensis*) were found on the xeric sites of deepest sand accumulation. A second community typified by an open aspen poplar forest associated with an alder (*Alnus crispa*), willow (*Salix* spp.) and rose (*Rosa acicularis*) shrub layer was also identified. Bearberry was also the major ground cover species of this community.

It appears that this second, more mesic, community inhabits those areas where plant species can penetrate the local water table or take advantage of a cooler, moister, north-facing aspect. Most dunes and associated aeolian landforms are in part surrounded by organic terrain typified by a high water table. The organic terrain - mineral soil boundary possesses the best moisture regime of the Aeolian Plain Land System. Hence, a narrow dense growth of aspen, willow, alder, rose and occasional white spruce (*Picea glauca*) inhabit this interface.

The Aeolian Plain is composed of 11 individual land types (Table 2). Land type nomenclature was adapted to describe the many intergrades of landforms found in a parabolic dune field. The use-limitation table (Table 1) provides a more detailed summary of each land type.

b) *Land System 2 - Organic Terrain:* Organic terrain covers approximately 25 percent of the planning area. This land system is defined by a predominance of organic soils that are permanently or intermittently water saturated. The water table may persist for a time at, or above the ground surface but may drop well below the surface seasonally (S.B.L.C., 1969). For the present study, this land system has been divided into three land types treed bogs, sedge fen and open water. The soils of this land system are of the Organic Order and at least 40 cm in depth.

Land Type 2.1 (Treed Bog) is composed of strongly acidic fibric organic soils of at least 60 cm in depth. The forest cover is predominantly black spruce (*Picea mariana*) and tamarck (*Larix laricina*). The shrub layer is composed of labrador tea (*Ledum groenlandicum*) and willow (*Salix* spp.) while the ground cover is primarily *Sphagnum* spp. mosses.

Land Type 2.2 (Sedge Fen) consists of Mesisolic soils of at least 40 cm in depth. Sedge fens usually occupy the "blow-outs" found upwind of the parabolic dunes. The dominant vegetation of this land type is sedges (*Carex* spp.) and reed grasses (*Calamagrostis* spp.).

c) *Land System 3 - River Valley:* the Wapiti River Valley occupies approximately 40 percent of the planning area. This land system is subdivided into three distinct land types: rough and broken valley walls, river terraces above major flood stage and point bars within the

TABLE 2

	LAND TYPE	
LAND SYSTEM 1, AEOLIAN PLAIN	1.1	large parabolic dunes
	1.2	small parabolic dunes
	1.3	large dune ridges
	1.4	small dune ridges
	1.5	pseudo dunes
	1.6	non-dune plain - xeric community
	1.7	non-dune plain - mesic - xeric community
	1.8	non-dune plain - xeric community - 5-9% slopes
	1.9	non-dune plain - mesic community - 2-5% slopes
	1.10	non-dune plain - mesic community - 5-9% slopes
	1.11	man-made scars

Table 2: Aeolian Plain Land Types in Land System 1, Wapiti-Grande Prairie Planning Area

modern flood plain. The river valley is a geomorphic subdivision and therefore acknowledges considerable variation in parent material. Dunes and dune-like forms resulting from past aeolian processes are found within the valley. For convenience these features were classified within Land System 1, the Aeolian Plain.

Land Type 3.1 (Rough and Broken Valley Walls) has slopes ranging from 15 percent to greater than 60 percent. The vegetation is primarily mesic while the soils are predominantly Brunisolic or Regosolic. Slopes ranging from 2-5% are quite typical of Land Type 3.2 (River Terraces). Significant subsurface gravel deposits occur within this land type. In some instances organic terrain is found covering the terraces. Land Type 3.3 (Point Bars) is seasonally flooded land adjacent to the Wapiti River. The 2-5 percent slopes of this land type are indicative of active channel migration. Thick groves of willow and poplar are the characteristic plant species of these areas.

Use - Limitation Table

The use-limitation table (Table 1) indicates certain limitations and suitabilities of land types for designated land uses. The table is based on previous work by Greenlee (1973 and 1974), Holland and Coen (1976) and Leskiw (1976). The table was developed to act as a tool for the planning team. The land type interpretations are indicators of predicted response under different land uses; not land use recommendations. Using the table in conjunction with the Ecological (Biophysical) Land Classification map (Figure 4), the planning team can predict the type and degree of limitation likely to be present for specific land uses in each land type designation. The specific limitations used in the table as well as the severity of the limitations are expressed in Table 3.

ELC APPLICATION

All land types as expressed in the Ecological

TABLE 3

LIMITATIONS

1. Flooding
2. Seasonally high groundwater table
3. Slope
4. Rapid permeability
5. Surface soil texture
6. Groundwater contamination
7. Organic Soil
8. Susceptibility to frost heave
9. Thin Ah horizon

DEGREE OF SEVERITY

S Slight to no limitations; free of limitations that effect the intended use, or the limitations are easy to overcome.

M Moderate limitations; limitations that need to be recognized but can be overcome with correct planning, careful design and good management.

V Severe limitations; limitations severe enough to make the intended use questionable.

Table 3: Land Use Limitations and Degree of Limitation Severity (to be used in conjunction with Land Use Limitation Table 1).

(Biophysical) Land Classification can be used for differing land use activities. However, some land types have slight limitations to use while others have moderate to severe limitations. Properties of differing land types which affect most land uses in the Wapiti-Grande Prairie Sand Dunes Area include susceptibility to flooding, organic soil and slope. Due to the sandy parent material of the Aeolian Plain, slope is of primary importance to land use decision making in that Land System. Not only is slope of consideration as a use-limitation but the ecological fragility of land types (that have sand parent material) is directly proportional to increase in slope. Other properties of land types which affect land uses include: seasonally high groundwater table, surface soil texture, groundwater contamination, susceptibility to frost heave, thin Ah horizon and rapid permeability.

To aid in the planning of the Wapiti-Grande Prairie Sand Dunes Area, land types which had similar use-limitations for the same land use were grouped together. For the purposes of the present plan, the units formed by the amalgam of land types (based on similar use-limitations) are called *Ecological Planning Units* (Figure 5). Ecologic Planning Units foster an appreciation of the specific interlocking characteristics that may affect differing land uses as well as the effect these may have on the planning unit.

For example; in the present planning area the Ecological Land Classification recognized three separate land types termed *treed bog*, *sedge fen* and *open water*. Although each of these land types has its own innate set of characteristics and qualities, they all have severe limitations to land uses which require facilities (buildings, septic tank fields, playgrounds, etc). Due to their similar limitations (seasonally high water table, groundwater contamination, susceptibility to frost heave) for facility oriented land uses, the three land types have been grouped together to form the Ecologic Planning Unit *Organic Terrain*. This concept has been applied to all land types which have similar use-limitations for the same land use as well as land types where ecological fragility is directly proportional to increased slope. As a result, six Ecologic Planning Units (*Organic Terrain*, *Non-Dune Plain*, *Small Dunes and Ridges*, *Large Dunes and Ridges*, *Valley Breaks*, and *Seasonally Flooded*) have been identified for the present study.

Ecological Land Use Matrix

The Wapiti-Grande Prairie Sand Dunes Area has great attraction to the residents of Grande Prairie and environs for both formal and informal recreational use. Other land uses in the Planning area include sand and gravel extraction, agriculture and peat extraction. Studies prepared in the past by the Peace River Regional Planning Commission as well as consultants hired by the County of Grande Prairie recommended that the present area of study be utilized for active recreation, while land east of the Resources Road be protected for passive recreation. Based on the findings of earlier studies as well as present land uses and dispositions and projected future land use needs, conservation, agriculture, residential, industry and recreation are considered as alternative land uses for the Wapiti-Grande Prairie Sand Dunes Area.

Based on present as well as projected land use needs, an Ecological Land Use Matrix (Table 4) was developed. The matrix indicates possible land use activities within various Ecological Planning Units. The matrix is not a plan but indicates the capability of Ecological Planning Units to support various land use activities. The ecological land use matrix was used as a tool to help in the development of an integrated management plan for the Wapiti Sand Dunes Area.

THE PLAN

To prepare an integrated management plan, it is necessary to understand the inherent physical use-limitations of the area in question to support the types of land use under consideration. For the Wapiti-Grande Prairie Sand Dunes Area this was accomplished through the preparation of an Ecological Land Classification. Ecological Land Classification provided the means of discriminating segments of the landscape into Ecological Planning Units. Based on use-limitations alone, Ecological Planning Units provided an idealized distribution of activities in the planning area. Figure 6 portrays the proposed integrated management plan for the Wapiti-Grande Prairie Sand Dunes Area. The proposed allocation of land uses is an attempt to maximize public enjoyment for recreation while minimizing environmental degradation. As well, the plan addressed itself to the land use needs of industry and municipal and public utilities. Predicated on this approach, the following types of land use were proposed for the study area: 1) Conservation, 2) Non-Facility Recreation, 3) Facility Recreation, 4) Municipal and Public Utilities, 5) Industrial Park, 6) Sand and Gravel Extraction and 7) Private Land.

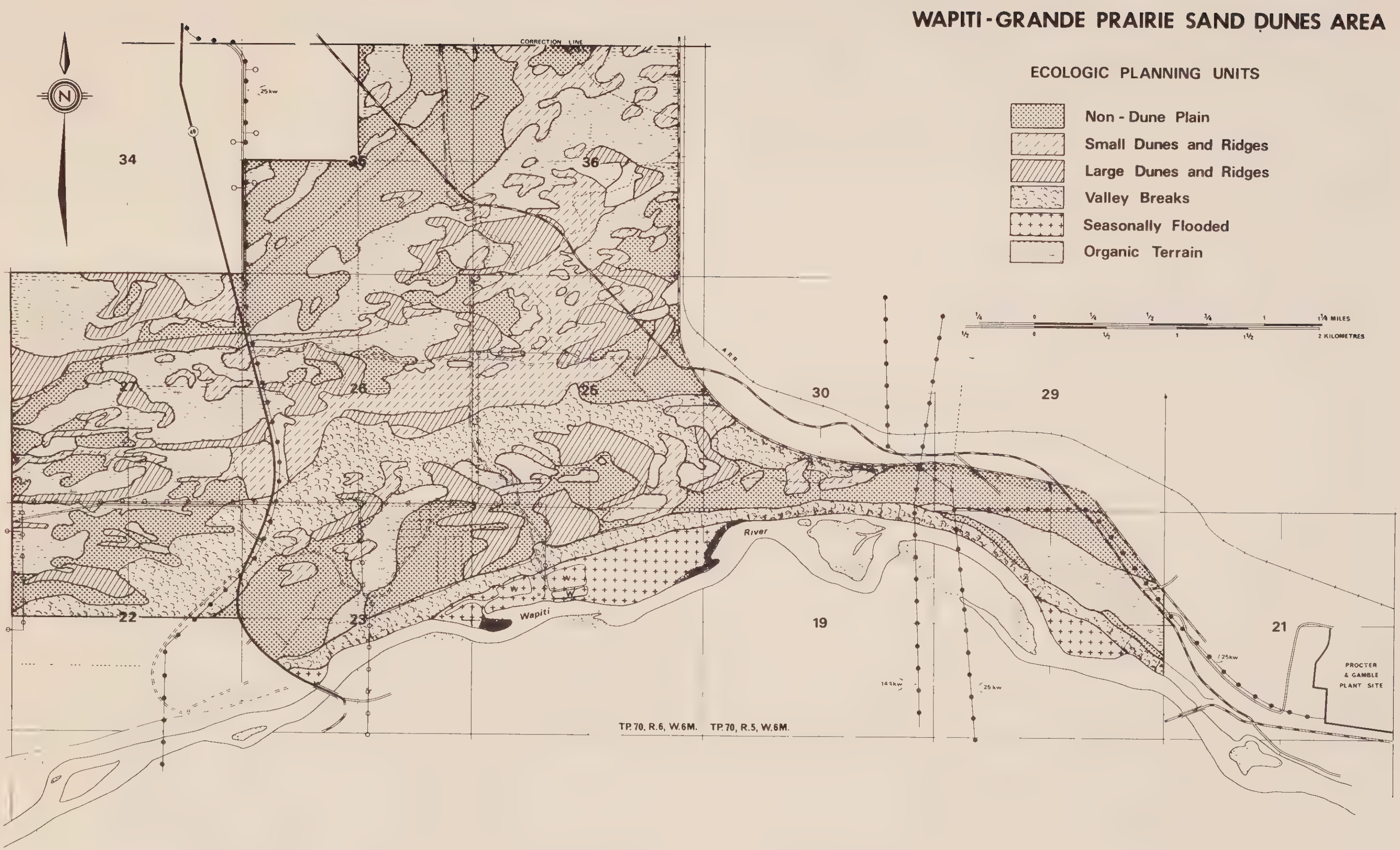


Figure 5: Ecological Planning Units in Wapiti-Grande Prairie Sand Dunes Area.

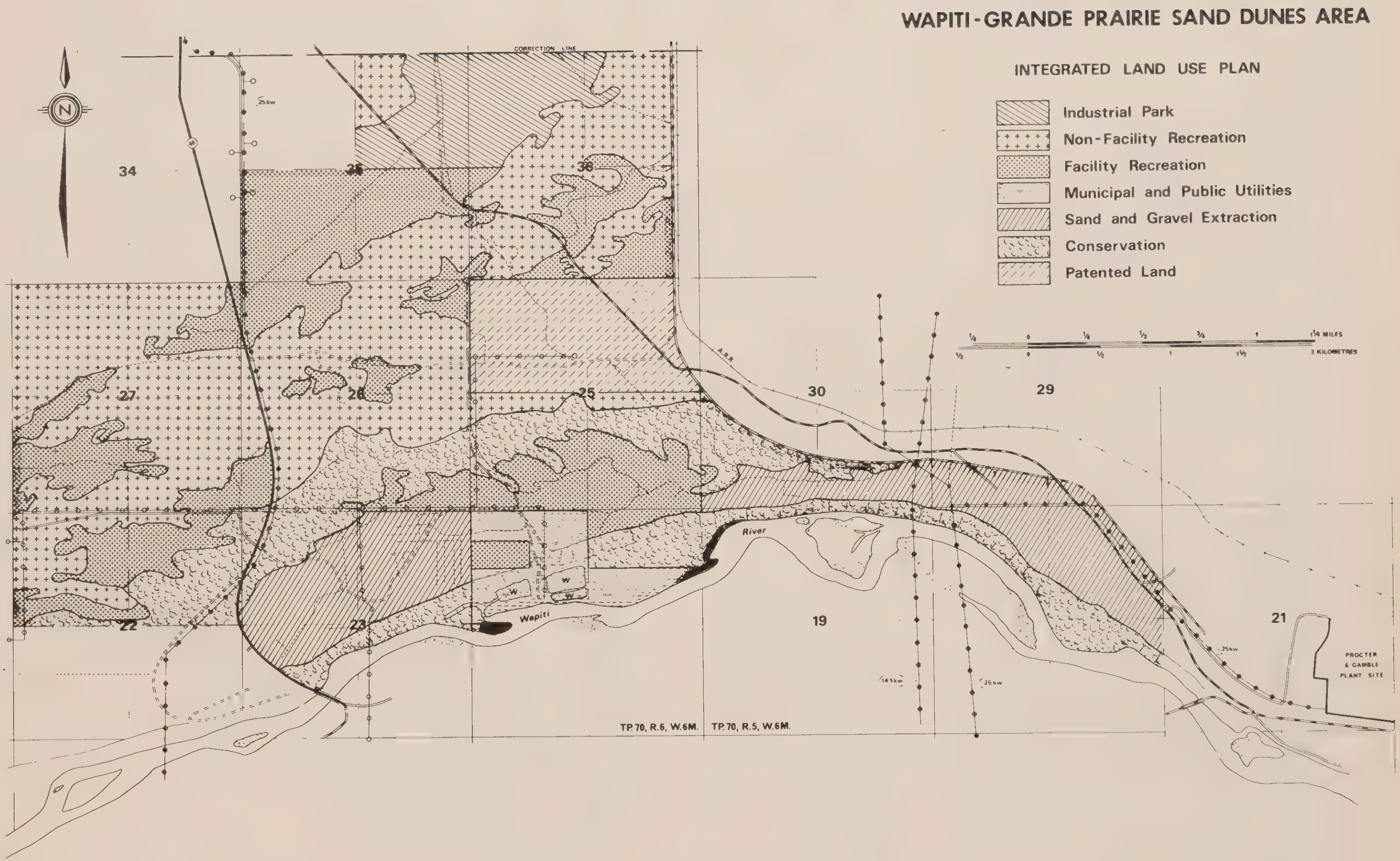


Figure 6: Integrated Land Use Plan for Wapiti-Grande Prairie Sand Dunes Area, Alberta

Table 4: Ecological Land Use Matrix

Ecological Planning Unit / Activity	Recreation 1	Recreation 2	Recreation 3	Recreation 4	Industrial	Agriculture	Residential	Conservation
Non-Dune Plain	A	C	A	A	A	A	A	C
Small Dunes and Ridges	A	C	A	A	A	A	A	C
Large Dunes and Ridges	X	A	X	A	X	X	X	C
Valley Breaks	X	A	X	A	X	X	X	C
Organic Terrain	A/S	A/S	X	A/S	X	A/S	X	C
Seasonally Flooded	A/S	A/S	X	A/S	X	A/S	X	C

Recreation 1 - motorized

Recreation 2 - non-motorized

Recreation 3 - group facility

Recreation 4 - group non-facility

C - Compatible - This use is compatible under normal guidelines and land use regulations.

A - Appropriate - This use may be compatible under certain circumstances but with stricter than normal controls.

A/S - Appropriate Seasonally - This use may be compatible under certain circumstances at specific times of the year but with stricter than normal controls.

X - Not Compatible - This use is not compatible with the intent or capabilities of the ecologic planning unit.

Conservation

This land use type protects the steep valley walls as well as land seasonally flooded by the Wapiti River. The intent of the designation is to preserve environmentally sensitive terrain. Dispersed informal land use activities such as hiking and cross-country skiing or other non-mechanized forms of recreation will be permitted in *Conservation* areas. Land uses adjacent to conservation areas will be governed by the *Alberta Environment Conservation Guidelines*.

Non-facility Recreation

The intent of this land use type is to provide a wide range of dispersed outdoor activities in a natural setting. Due to the ecological fragility of the large sand dunes and sand ridges, management emphasis in this area will be on the maintenance of ground vegetation cover. *Non-facility Recreation* areas will not permit motorized forms of recreation or types of recreation requiring major improvement to the land.

Facility Recreation

Facility Recreation areas comprise the non-dune plains as well as the smaller dunes and ridges of the study area. Although the entire study area is fragile ecologically, areas designated *Facility Recreation* are the most tolerant to use. The primary goal of this land use type is to provide areas where recreation pursuits requiring intensive development or improvement to the landscape can take place. The allocation of recreational uses to specific sites will be based on land capability and suitability for the specific use as well as compatibility with adjoining uses.

Municipal and Public Utilities

Due to unique management requirements, a special use area designated *Municipal and Public Utilities* is applied to lands held by the City of Grande Prairie for water intake and purification. These lands include legal sub-division 9, 10, 11, 12, 13, 14 of 24-70-6-W6

Industrial Park

Industrial expansion is anticipated in the Grande Prairie region. As a result, the County of Grande Prairie recommends that an area of approximately 64 ha be accommodated in the planning area for an industrial park. Infrastructure and transportation needs are a major concern to this type of land use. Consequently this land type is located in the northern part of the study area adjacent to an existing industrial park in the south half of 1-71-6-W6. Permitted industrial uses of the park would be non-polluting and appropriately buffered from adjacent land use priorities.

Sand and Gravel Extraction

Due to limited quantities, gravel deposits of the upper Wapiti River terraces are significant to the Grande Prairie Region. Consequently, areas of present mining, as well as areas of economically recoverable gravel have been designated for this use. All mining operations are governed by the *Alberta Energy and Natural Resources Schedule of Clauses* for sand and gravel operations. Once site work is complete, reclamation guidelines stipulated in each lease will be followed.

Private Land

Within the study area, the north half of 25-70-6-W6 is privately owned land. Although the government does not have tenure regarding patented land, it is hoped that the title holders of this land will adopt the proposed concepts of the plan and accept them as their own.

CONCLUSIONS

Within the Resource Evaluation and Planning Division of Alberta Energy and Natural Resources awareness of the importance of Ecological (Biophysical) Land Classification for land use planning is becoming more and more apparent. The development of an integrated land use management plan for a part of the Wapiti-Grande Prairie Sand Dunes Area is but one example of this awareness.

The present study indicates that the Ecological (Biophysical) Land Classification approach to the collection and analysis of landscape data provides a planning team with salient, comprehensive information about a planning area not in a single disciplinary manner but in a form accentuating its ecological interconnectedness. The ELC data package fosters within a planning team an appreciation for the effects differing land uses may have on the landscape as well as the effect differing landscapes may have on land use.

Although the Wapiti-Grande Prairie Sand Dunes case study was at a scale large enough to delimit land types within a planning area, the Ecological (Biophysical) Land Classification approach can provide viable planning data at smaller scales. For example, in a hypothetical regional planning area an ELC analysis to the Land System level, combined with a meaningful use-limitation table could easily be interpreted to provide Ecologic Planning Units of significance for land use decisions concerning arable agriculture, improved and unimproved grazing, forestry or recreation.

Clearly, the hierarchical framework of the Ecological (Biophysical) Land Classification method, its ability to meaningfully portray the landscape at widely divergent scales and its form of presentation based on ecological unity make the ELC method unparalleled in processing landscape data for planning purposes.

REFERENCES

Greenlee, G. M. 1973. Soil Survey of Lesser Slave Lake Provincial Park and Interpretation for Recreational Use. Alberta Institute of Pedology. No. M-73-12. Edmonton.

Greenlee, G. M. 1974. Soil Survey of Gregoire Lake Provincial Park and Adjacent Area and Interpretation for Recreational Use. Alberta Institute of Pedology. No. M-74-13. Edmonton.

Holland, W. and G. M. Coen 1976. Soils of Waterton Lakes National Park. Alberta Institute of Pedology. No. 5-73-33, NOR-X-65. Edmonton.

Leskiw, L.A. 1976. Soil Survey and Interpretations, Peerless-Graham Lakes Area. Alberta Institute of Pedology. No. M-76-2. Edmonton.

May, L. 1977. The present role of biophysical information in urban and regional land use planning in Canada. *in* Proc. Workshop on Ecological Land Classification in Urban Areas, Toronto, Ontario. Lands Directorate ELC Series No.3, Environment Canada, Ottawa. pp. 11-12.

Subcommittee on Biophysical Land Classification (SBLC). 1969. (comp. and ed. by D.S. Lacate). Guidelines for Biophysical Land Classification. Can. For. Ser. Publ. No. 1264. Ottawa. 61 p.

ABSTRACT

The development of an integrated land use management plan for the Wapiti-Grande Prairie Sand Dunes Area, south of the city of Grande Prairie, Alberta, is outlined as an example of the comprehensive ecological data packages used by the Department of Energy and Natural Resources for land management in Alberta. The Area, comprising 18 km^2, was mapped at the land system and land type levels. The form of presentation and the various ELC mapping scales are seen as unparalleled for effective processing of landscape information and land planning. (Ed. Abstr.)

RÉSUMÉ

L'élaboration d'un plan intégré de gestion de l'utilisation des terres dans la Région des dunes de sable (Grande Prairie-Wapiti) est présentée ici comme exemple de l'utilisation des données écologiques globales par le ministère provincial de l'Énergie et des ressources naturelles pour la gestion et la planification des terres en Alberta. La région, d'une superficie de 18 km^2, a été cartographiée aux niveaux du système écologique et du type écologique. On estime que la forme de présentation et les diverses échelles de cartographie utilisées au traitement des données sur le territoire et la planification des terres, donnent des résultats d'une efficacité sans pareil. (Rés. Éd.)

A METHODOLOGY FOR ENVIRONMENTAL IMPACT ANALYSIS IN PREDESIGN AND PLANNING STUDIES

E. E. Mackintosh
Dept. of Land Resource Science
University of Guelph

Ecological Services for Planning
Guelph, Ontario

ABSTRACT

A methodology is presented for conducting environmental planning and assessment studies. Emphasis is placed on discussing techniques for managing the group's activities and structuring of the team.

RÉSUMÉ

L'auteur expose une méthodologie visant l'exécution d'études de planification et d'évaluation environnementales. Il insiste sur la gestion des activités du groupe et sur l'organisation de l'équipe de travail. (Trad. Éd.)

INTRODUCTION

The decade of the seventies is seeing the emergence of a new discipline dealing with environmental planning and assessment. It is an applied science owing its roots to the many and varied traditional disciplines, but more important, it is a science dealing with systems, systems concepts and integration of parts to synthesize the whole. Much of the content of these traditional disciplines is available in published books and papers, but the process of integration and synthesis is only in its embryonic stages of development. This is reflected in the lack of published methodologies or agreed upon approaches for dealing with environmental planning issues. In the initial stages, it is important for those involved in environmental planning to publish their approaches or methodologies. Science progresses through constructive criticism and the evaluation and development of an appropriate methodology must, therefore, be exposed to this process in order to improve upon what has gone before.

The very nature of the science implies that we are dealing with holistic views or systems. It presupposes the integration of the components of the system to reflect the whole (management of the problem) and the existence of a team or group capable of addressing the problem (management of the group). The division of the problem into these two categories is implicit in most environmental studies, yet few publications have addressed their interface. Indeed, structuring of the team in interdisciplinary studies is crucial to the projects success.

Not withstanding some of the difficulties in integration of data, the common philosophy throughout environmental studies is one of systematic problem solving within group situations. What follows is an attempt to outline an approach to environmental planning that has evolved over the past seven to eight years. From its inception as a research project (Centre for Resources Development, 1971; 1972), it has been refined and redrafted numerous times through teaching to graduate and undergraduate students, discussion among colleagues and application of the ideas in private practice. It outlines an approach to problem solving and most important, the techniques used to attain group harmony and integration of the ideas.

A majority of the projects undertaken by our group have dealt with predesign analysis and feasibility studies (Ecological Services for Planning Ltd., 1975;1978). These are defined as preliminary studies dealing with the collation and processing of information for the purpose of selecting among alternative plans or courses of action. They commonly involve development of subdivision plans for draft plan approval.

THE APPROACH

Systems Concepts

Our approach is based on the application of general systems theory (Bertalanffy, 1972) to problem solving. The idea of systems is indispensable when dealing with the natural environment and environmental problems. Environmental planning deals with the assessment or prediction of changes to the environment as a consequence of intrusion by human activities. To accomplish this, one must define the system in terms of its component parts, their interrelations and their functional relations. Only then, is one able to adequately assess or determine the impact of the intrusions.

The application of systems concepts is not an end in itself, but is a means to gain an appreciation of the scope of the problem under examination. Systems concepts provide the umbrella or guiding philosophy for the team and development of logic networks provide the focal point for initiating and guiding the team throughout the duration of the project.

Structuring the Team

Although the terms multidisciplinary and interdisciplinary are common place in todays vocabulary, it seems as though few people have a clear understanding of the team structure required to fulfill their respective objectives. Indeed, most environmental studies to date have relied on a multidisciplinary approach i.e. a banding together of disciplines under a common umbrella for budgetary or other reasons. The reports generated from such studies often represent a compendium of individual disciplinary reports with a common summary and recommendation section as the contribution to integration. In our experience, integration and synthesis of information beyond that attained in simple sieve mapping techniques or computer display methods is largely dependent on the structure and composition of the team. Most techniques used by groups for synthesis operations (e.g. matrices, sieve mapping, computer graphics) are information management techniques and by themselves do not assure integration and synthesis of information to understand how a system functions; hence, the preoccupation with management of the team and methods that facilitate their performance (e.g. system concepts and logic networks) in this paper.

Our team structure relies on a core of individuals which acts as a nucleus and provides team stability. Additional members may come and go depending on the specific needs of the project. The core team appears to be similar to Greenall's concept of a *core group* (Greenall, 1977) and it would be interesting to see if some concensus is beginning to emerge on team structure in this regard.

The core group concept appears to satisfy a number of concerns that arise in interdisciplinary investigations (Kendall and Mackintosh, 1978). Many of the socio-psychology problems common to small groups (e.g. interpersonal problems, communication problems and paradigm conflicts) gradually disappeared after several years of collaboration between team members. The development of these so-called interdisciplinary skills are long term and some individuals will never develop them. Indeed, socio-psychology studies (Miller, unpublished data) suggest that this latter group of individuals outnumbers those with positive attributes suited to interdisciplinary work.

Obviously, it is unrealistic to think that each new group undertaking an interdisciplinary project will have the opportunity to develop these skills. There are, however, a number of techniques that have been used successfully in initiating and promoting harmony within an interdisciplinary team.

From the onset it should be recognized that some individuals are against group problem solving and will devote their time, effort and energy to scuttling the whole venture. It is imperative to deal with these individuals early in the game and at a minimum, they should be eliminated from the core group, if not the whole team. Hollings and Chambers (1973) have written a delightful article on the different actors in groups and such players are known and discussed at lengths in books on the socio-psychology of small groups (Cathcart and Samovar, 1974).

The core group in our firm consists of individuals who are all rather strong willed and who tend to express their opinions in a forthright manner. This is a positive feature of the group since all the issues are in the forefront and can be dealt with directly. The composition of the core group is of lesser importance, although there are obvious benefits to having the individual backgrounds correspond to the disciplines most commonly represented in environmental planning studies. We have also found it beneficial to include a planner or landscape architect in the core group as a means of smoothing the transition from the environmental data base to generation of the design concepts.

Because management is such an important component in the success of projects, all of the core group must be acquainted with the basics of project management. One technique, logic networks, is a simple, yet powerful management tool which can be used to initiate and guide the group's activities.

Logic Networks

Once the group has defined the system (or problem), then an in-depth analysis gives rise to a detailed set of subsystems. These subsystems or subproblems become tasks for the group and can be represented in sequential fashion as a logic network (called flow diagrams by many people). Construction of the logic network serves several invaluable functions for the group's activities as follows:

1) It serves as a task to initiate the group's

activity.

2) In order to construct a detailed logic network, an in-depth analysis and understanding of the problem is required by the group (it breaks a complex problem down into simpler levels that can be dealt with by discipline).

3) It highlights areas where there is an obvious need for integration between disciplines.

4) It serves as a guide to orchestrate the group.

5) It allows each individual to gain a perspective of where he/she fits into the group and what the group's expectations of him/her are.

6) It frees the individuals from the classical trap of going deeper and deeper into a problem with less and less relevance i.e. continuity in precision of data.

7) It familiarizes the group members with the practical limitations of scheduling and budgets. (The addition of time to the logic network allows one to use management techniques such as critical path analysis to schedule events according to time and budgetary constraints).

Completion of a detailed logic network allows the group to revert to a multidisciplinary structure where each discipline, can to varying degrees, proceed with their respective tasks. In the section that follows, explicit reference it made to those phases of the investigation which can proceed in this inter- and multidisciplinary fashion.

CONDUCTING THE STUDY

The general sequence of events that might take place in a predesign investigation are shown below. These are not unlike the listing that might appear for any problem solving exercise.

1. General problem definition
   - most often the proposal; goals, broad objectives, definition of the system; a task of the core group.

2. Structuring the team
   - performed by core group.

3. Detailed problem analysis
   - detailed objectives and task list; completion of logic network; a group task.

4. Description of the system
   - review of available information; conducting resource inventories; can proceed by discipline.

5. Functional relations of system
   - putting the parts back together (synthesis); accomplished by group interaction.

6. Interpretative phase
   - information management; opportunities and constraints maps; tasks are partitioned between core group and entire group members.

7. Synthesis of design alternatives
   - designer in conjunction with core group.

8. Evaluation of alternatives
   - identification of impacts; remedial measures; evaluation of systems performance; accomplished by group interaction.

9. Redesign and choice of alternatives
   - identification of impacts, remedial measures rehabilitation programs; accomplished by group interaction.

Once the detailed problem analysis is completed by group interaction, the team members may disperse and individually conduct their inventory analysis, although, even at this stage, we have found it beneficial to work as a closely knit group. This is a particularly good tactic if one is dealing with a new core group since it helps to develop mutual respect and understanding amongst team members. Moreover, it serves as an excellent educational tool for the entire group.

Scale and Decision Making

Prior to undertaking inventory analysis, it is necessary to decide upon the level of detail of information. Although this may seem a simple task, we have found that maintaining precision in data collection is difficult, particularly with inexperienced personnel aboard. There are two sources of variations. The most important is to match up the level of decision making with the detail of inventory analysis. One should always remember that environmental planning and assessment are aids to decision making and it is the latter concern that determines the level of detail. In this respect we would generally concur with the guidelines proposed by Dorney (1976). In predesign analysis studies, we have rarely found that one can justify quantitative analysis as an example.

The second problem is one of maintaining continuity (level of detail) between team members.

For instance, there is little point in undertaking a quantitative assessment of species composition in a terrestrial wildlife study if vegetation analysis is to consist of qualitative assessment of site quality. Unfortunately, there are no hard and fast guidelines to direct the uninitiated in this area. For predesign subdivision studies, a scale of 1:10,000 seems to be most appropriate for collecting resource inventory data. This allows one to cartographically display areas of about one half hectare, yet it provides sufficient indepth and onsite analysis so as to prevent overlooking site characteristic important to design. Although the common scale for displaying information is 1:200 to 1:4800, precision of the resource data is determined by the 1:10,000 scale.

Describing the Systems

Natural systems have both structure and function which serves to describe the system. It is not necessary to understand the system in all its complexity, rather certain key factors often control a large percentage of the operation. It is only necessary, therefore, to know certain key processes to predict the response of the system and the inventory analysis should be directed toward describing those specific attributes.

Approaching the problem from a systems perspective also affords one the opportunity of evaluating the system from its own rationale, structure and function rather than from predetermined human criteria. In addition, it reduces significantly the size of the resource data base that requires manipulation for decision making. These are the main reasons for adopting the opportunity and constraint mapping approach but others include: 1) many constraints can be overcome by design and design standards can therefore be included in the text, and 2) capability/suitability ratings are normally based on limitations (negatives) whereas opportunity maps show the alternative land uses possible for an area. This simplifies the designers' task in formulating alternative designs or plans.

Synthesis and Integration

This stage represents the most important phase of environmental investigations, yet, it is probably the least understood and the most ill conceived step of the numerous investigations that the author has reviewed or been involved with. Most of the tools alluded to for accomplishing synthesis and integration (e.g. computer display systems) are information management tools, and by themselves, do not ensure any measure of success. Simulation models show considerable promise (Van Dyne and Abramsky, 1975), however the simple linear models do injustice to complex systems whereas the larger, more complex models are still in the development stage. Sufficient funds, time and baseline data are not available to make them operational at this point in time.

What then is the solution? For smaller projects, the core team of experts still seems to provide the most comprehensive approach to integration and synthesis. Larger projects may require more sophisticated information management tools, but again, group interaction amongst team members seems indispensible in this phase of the problem solving exercise.

Presenting the Information

The preceding leads to two problem areas in environmental investigations. The first deals with the resource information base and the second, with the format of data presentation.

In our experience (and I would caution people to recall we have dealt primarily with predesign analysis studies), resource inventory data collected from routine, ongoing survey programs e.g. county soil survey reports are far from adequate for environmental studies. In situations where information is lacking, clearly, it provides people with additional decision making capabilities. Nevertheless, most projects undertaken in an urban environment are site specific and to develop this *systems philosophy*, onsite inspection is required. The problem with routine surveys at detailed scales relates to their narrow and preconceived objectives (the latter being governed by historical events) that arise from a single disciplinary venture. It is the assessment of the system's health and resilience that are at issue and routine resource inventories usually only provide a description of the system.

Presentation of the information in a format that is simple and yet all inclusive, is critical to the success of the project. For larger projects, computer display and handling may be required, purely for efficiency reasons. We have utilized computer graphics at the subdivision level (Ecological Services for Planning Ltd., 1978) but a glaring shortcoming in their use is the tendency in hearings for people to feel that a 'snow job' is in the offering and secondly, from an operational standpoint, there are few clients geared to this level of sophistication for daily use of information. For these reasons (i.e. simplicity of use and understanding by both designers and the public, utility of the information to the client, and team structure) we have devel-

oped a preference for constraint mapping in most projects. Constraint maps display the essence of the resource inventories in a concise, distilled fashion that can be used as the basis to generate designs or opportunity maps (Ecological Services for Planning Ltd., 1977). In most instances, two to three constraint maps are adequate (Dorney, 1976) to display the key issues. The constraint map approach allows one to highlight those limitations for which solutions are available within the recognized 'state of the art' and further, it identifies those limitations for which design solutions are not readily apparent. Identification of this latter group of limitations is crucial to determining the site impacts.

Opportunity maps are developed on the basis of the positive attributes of land for specified use and present the alternative forms of land uses that are possible for an area. This approach initially developed out of the Hanlon Creek Study (Centre for Resources Development, 1971; 1972) and was further refined and adapted to computers (Chisholm, School of Engineering, University of Guelph - unpublished data) for use in planning several subdivision developments (Ecological Services for Planning Ltd., 1978; Triton Engineering Services Ltd., 1973).

Evaluating the Alternatives

Environmental planning studies culminate in the production of a design or series of design alternatives. Once generated, each design is evaluated and impacts are identified usually in the form of an environmental impact statement including the possibility of mitigation measures and remedial works. This phase is accomplished through discussions in group meetings of the team.

SUMMARY

A methodology for environmental planning and assessment studies is discussed in terms of managing the problem and managing the group. Emphasis is placed on the importance of managing the group in interdisciplinary projects, in particular, the team structure and management techniques required for promoting intragroup harmony. The *core group* concept of team structure has been found to be the most effective in realizing successful group performance.

The approach involves the application of systems theory to problem solving. Here, systems concepts are used as a paradigm of approach and systematic problem solving provides the strategy. The need to define the problem in terms of systems and characterizing these by their component parts, their interrelationships, and their functional relationships is stressed as a means of overcoming the volumous data bases and information management problems generated as a result of the more common check-list (recipe) approaches. Integration and synthesis of the data still remain the key components to a successful project and group discussion in team meetings still seems to provide the optimal solution to these problems. Other tools used by groups for integrative purposes, such as computer mapping or matrices, are information management tools and by themselves, do not ensure any measure of success in the synthesis phase.

In the oral presentation emphasis was placed on case study histories (Centre for Resources Development, 1971; 1972; Ecological Services for Planning Ltd., 1977; 1978; Triton Engineering Services Ltd., 1973) as a means of tracing the evolution of our approach from its inception to present day. Visual aids were presented from: the Hanlon Creek Study (Centre for Resources Development, 1971; 1972) to demonstrate the need for evolving to a systems approach; the Pukaskwa campground investigation (Ecological Services for Planning Ltd., 1977) to illustrate the use and advantages of constraint maps for generating design alternatives; and the Forks of the Credit Study (Ecological Services for Planning Ltd., 1978) to demonstrate the use of opportunity maps in estate lot planning.

ACKNOWLEDGEMENTS

I am grateful to Mr. Jerry Hagarty, Ecological Services for Planning Ltd., for reviewing the manuscript and offering constructive criticisms.

REFERENCES

Bertalanffy, L. von. 1972. General System Theory - a Critical Review. *in* Systems Behaviour. (ed. by J. Beishom and G. Peters). The Open University Press, London. pp. 28-49.

Cathcart, R.S. and L.A. Samovar (editors). 1974. Small Group Communcation: A Reader. Wm. C. Brown Co., Iowa.

Centre for Resources Development. 1971. Hanlon Creek Ecological Study. Phase A. (Prepared for the City of Guelph and Grand River Conservation Authority). 66 p.

Centre for Resources Develcpment. 1972. Hanlon Creek Ecological Study. Phase B, Volume 1. (Prepared for the City of Guelph and Grand River Conservation Authority). 71 p.

Dorney, R.S. 1976. Biophysical and Cultural-Historic Land Classification and Mapping for Canadian Urban and Urbanizing Land. *in* Ecological (Biophysical) Land Classification in Urban Areas. (ed. by E. Wiken and G. Ironside). ELC Series No. 3. Lands Directorate, Environment Canada. Ottawa. pp. 57-71.

Ecological Services for Planning Ltd., 1975. Environmental Appraisal for the Mansfield Chalet Development. (Prepared for Triton Engineering Services Ltd.).

Ecological Services for Planning Ltd. 1977. Environmental Evaluation for Campground Development in Pukaskwa National Park. (Prepared for Parks Canada - Ontario Region). 51 p.

Ecological Services for Planning Ltd. 1978. Forks of Credit Estate Environmental Appraisal. (Prepared for Triton Engineering Services Ltd.). 108 p.

Greenall, J.W. 1977. The Core Group as a Method for Integrating the Work of the Multidisciplinary Environmental Team. *in* Proc. Conf. Environmental Impact Assessment in Canada: Processes and Approaches. (ed. by M. Plewes and J.B.R. Whitney). Institute for Environmental Studies, University of Torotno. Publ. No. EE-5. pp. 145-157.

Hollings, C.S. and A.D. Chambers. 1973. Resource Science: The Nurture of an Infant. Bioscience 23: 13-20.

Kendall, S. and E.E. Mackintosh. 1978. Management Problems of Polydisciplinary Environmental Research Projects in the University Setting. Centre for Resources Development, University of Guelph. (In preparation).

Miller, A. The Role of Personality in the Education of Forestry Students. Unpublished Report, University of New Brunswick, Fredericton. 5 p.

Triton Engineering Services Ltd. 1973. Melody Village: Master Planning Study. (Prepared for Tranmer Securities Ltd.). 49 p.

Van Dyne, G.M. and Z. Abramsky. 1975. Agricultural Systems Models and Modelling: An Overview. *in* Study of Agricultural Systems. (ed. by G.E. Dalton). Applied Science Publishers Ltd., London. pp. 23-106.

APPROACHES TO SHORELINE MAPPING ON SOUTHERN INDIAN LAKE*

G. K. McCullough
Freshwater Institute
Fisheries and Marine Service
Environment Canada
Winnipeg, Manitoba

INTRODUCTION

The purpose of this paper is to describe the system of shoreline classification developed for Southern Indian Lake and to compare its hierarchical aspect with that described by the Subcommittee on Biophysical Land Classification (1969) and Jurdant (1977) for general ecological land classification applications. The Churchill-Nelson Rivers Impact Study (CNIS) shoreline classification was developed in 1972 to inventory lake and river shorelines to be affected by hydro-electric developments in the Precambrian Shield in northern Manitoba (Newbury et al, 1973; LWCNR Study Board, 1974). Included in the study were the Nelson, lower Churchill and Rat-Burntwood River system.

Since 1975, impact and monitoring studies on the newly created Southern Indian Lake reservoir have engendered further development of this shoreline classification. The volume of material eroded annually has been measured at 20 sites and correlated with the erosive component of incident wave energy (Newbury et al, 1978). Southern Indian Lake shoreline type mapping is designed to provide a base for extrapolation of these measured volumes.

In 1976 at seven sites on Long Bay, (an 11 km x 1 km bay near the south end of the lake), nearshore vegetation was surveyed and sampled, and samples were analyzed for major nutrients. (Shay et al, 1978). Detailed mapping of the shoreline of Long Bay was done to allow computation of nutrient and sediment input into the bay from flooded vegetation and eroded shorelines. In addition the maps are meant to facilitate extrapolation of data from studies of benthic ecology now in process.

The two projects required different levels of detail and have resulted in a hierarchical system with levels of classification comparable to the land type and land phase. The Subcommitte on Biophysical Land Classification (1969) defined land type as "an area of land, on a particular parent material, having a fairly homogeneous combination of soil and chronosequence of vegetation." Jurdant et al (1977) have developed a subdivision of the land type, the land phase (une portion de territoire caractérisée par un combinaison relativement uniforme du sol et de la végétation). The significant difference is that a land phase unit describes a particular stand of vegetation existing at the time of mapping and thus could not comprise several stands differing only in stage of succession. In the Long Bay project it is necessary that existing vegetation communities be mapped.

THE CLASSIFICATION SYSTEM

In the 1972 CNIS classification system shorelines were represented by 14 shoreline types in three major catagories: shorelines in

CNIS Classification		Revised (SIL) Classification	
Bedrock		Bedrock	
11	Steep bedrock shoreline	11	Steep bedrock shoreline
12	Vertical bedrock shoreline		n/a*
13	Low bedrock shoreline)		
14	Bedrock-controlled shoreline w. overburden beach)	13	Bedrock-controlled shoreline
15	Low bedrock-controlled shoreline)		
Overburden		Overburden	
21	Ice-scoured till bank		n/a
22	Shoreline in coarse sediments)	22	Shoreline in coarse (glacial-fluvial) sediments
27	Low shoreline in coarse sediments)		
25	Shoreline in slumping overburden)	26	Shoreline in (glacio-lacustrine) fine sediments
26	Treed muskeg shoreline)		
23	Mild-sloped alluvial shoreline		n/a
24	Low alluvial shoreline)	28	Shoreline in (Recent alluvium
28	Low willow shoreline)		
Organic deposits		Organic deposits	
31	Floating fen	31	Organic shoreline

*n/a indicates not applicable to Southern Indian Lake.

Table 1: Shoreline Types of the CNIS System

* Abstract/Résumé on/à page 329.

bedrock controlled terrain, in unconsolidated mineral overburden and in deep organic deposits (Table 1). Each type was represented by a profile describing typical offshore and bank slopes, beach materials and width, backshore materials and stratigraphy, zones of floral communities and probability of permafrost.

In the revised classification system only six shoreline types are used (Table 1). Several of the original types are inapplicable to Southern Indian Lake, having been developed either for river channel or for Hudson Bay Lowland terrain Others are recognized as describing variants of basic types. The numeric designations have been retained and the descriptions are basically the same as in the original system. Certain features such as type of offshore vegetation, and beach materials and width are recognized as being variable. The most common associations are described for each type, (Newbury et al, 1973; LWCNR Study Board, 1974) but actual occurences of these features are mapped only at the more detailed phase level of mapping. Type 28 is shown in Figure 1 as an example of the manner in which each shoreline type is described.

Several subdivisions of shoreline types are made on the basis of parameters considered to have relatively minor influence on ecological associations characteristic of types. These parameters are particularly significant to extrapolation of measured eroded volumes, and can be interpreted from aerial photographs of as small a scale as used to map shoreline types. Thus they are mapped at shoreline type level, and not at the more detailed level described below. Subdivisions of shoreline types are listed in Figure 2.

The least integrated variables of the shoreline, offshore vegetation, beach materials and width, as well as relative bank stability, are mapped by listing them as they occur in the offshore, beach and bank zones. A detailed list of these variables is included in Figure 2. It is intended that nearshore zones of vegetation should also be mapped in this manner, although they were not mapped in this study.

RATIONALE FOR THE HIERARCHY WITHIN THE CLASSIFICATION SYSTEM

The revised classification system rests on two premises. The first is that geologic parent materials, slope, soil development and vegetation chronosequence, within regional climatic zones, are bound by ecological relationships internal to each unit of shoreline mapped. This premise stems from the general concept of the ecosystem (Odum, 1959, p.10) and was supported by a survey of 98 shoreline sites along the Churchill, Rat, Burntwood and Nelson Rivers in which many shoreline variables were observed to recur in relatively few combinations. The combinations are mapped as shoreline types.

The second premise is that external forces such as impinging wave or fluvial energy, water level fluctuations, and aspect have great influence over other features of the shoreline vegetation, beach material and width, and bank stability. These are relatively independent variables of the shoreline and do not associate in recurring combinations. Beaches may or may not have been developed from the adjacent backshore deposits. The beach materials mays have been carried by the littoral current from considerable distances along the shore.Width and slope of a beach depend as much on the seasonal fluctuation of water levels as on the backshore deposits. In contrasts with variable described by shoreline type, which are bound by strong internal ecological relationshops, these variables of phase occur almost randomly.

The natural distinction between dependent and independent parameters is reinforced by mapping scale constraints. Shoreline types have been interpreted from 1:63,000 scale aerial photographs and be mapped at a scale as small as 1:125,000. Although this scale corresponds to the scale of land systems as suggested by the 1969 *Guidelines* , these are shoreline types not whole systems. They are fairly homogeneous associations of slope, geologic materials and floral zonation. Land systems are defined by recurring patterns; these shoreline types are not. The landform from which each stretch of shoreline type has been carved can be mapped as an equally homogeneous association of soil and vegetation chronosequence, except for the narrow zones of the shoreline ecotone. The nature of the zonation is in itself generally characteristic for the shoreline developed out of that particular landform. It seems probable that shoreline types described herein could be interpreted with reasonable accuracy from a land type map, without recourse to aerial photographs. Shoreline types can be mapped at considerably smaller scales than would normally be required for land types simply because, as a linear feature of the landscape, they have no irregular boundary to delineate. From a purely functional viewpoint, they leave more room for annotation.

On the other hand, parameters mapped as phases of shoreline types, excepting offshore vegetation, beach width, sand beaches and wide bedrock

FIGURE 1

Shorelines with a broad, low willow and alder zone are typically regular and concave and occur around shallow embayments. They are most commonly associated with bedrock controlled shorelines of Type 13 and sometimes with treed muskeg shorelines of Type 26.

Relief is low; the profile is horizontal and less than 1.5 m above water level as far as 15 to 150 m from the water's edge, where begins a gentle rise to the uplands.

The low zone is over clay or sandy, silty clay greater than 3 m deep, underlain by bedrock. The bedrock rises gently and may outcrop in the backshore; it is commonly exposed on adjacent headlands. Where such shorelines are associated with treed muskeg, depth to bedrock is normally greater. The beach area is commonly of exposed sandy clay, but back of it the low zone may be overlain by up to 1 m of sphagnum or forest peat; more commonly the organic layer is less than 0.3 m thick. Permafrost occurs where the organic layer and drainage characteristics permit.

Typically an offshore zone of marsh vegetation is present; the nature of the marsh community varies significantly over the area mapped. It may consist of zones of Gramineae and Carex spp., commonly with Lemna sp., immediately adjacent to and onto the beach, or of offshore stands of Scirpus sp. Width of the zones is dependent on offshore slope, Gramineae typically growing on shore and in depths of less than 15 cm of water, Carex spp. growing from the water's edge into water up to 0.5 m in depth, and Scirpus sp. normally in 0.5 to 1 m of water. Large marshes may extend beyond 300 m from shore, with complete zonation of vegetation as described above and with Potamogeton spp. scattered throughout and beyond.

The characteristic zone of Type 28 is the broad belt of closed deciduous scrub stretching 15 to 150 m back from the water's edge to the first slopes. It is a zone of poor drainage and commonly of standing water in small pools. Dominant species are Alnus sp., and Salix sp. shrubs, with very scattered Betula papyrifera and Picea mariana shrubs and trees increasing in abundance with increasing distance from the shore. Common herbs include Mianthemum canadense and Cornus canadensis among species of Gramineae with a ground cover of feather mosses or Sphagnum spp.

Various communities may occur on the slopes beyond the willow zone; often treed muskeg develops on the poorly drained, clayey alluvial deposits further inland.

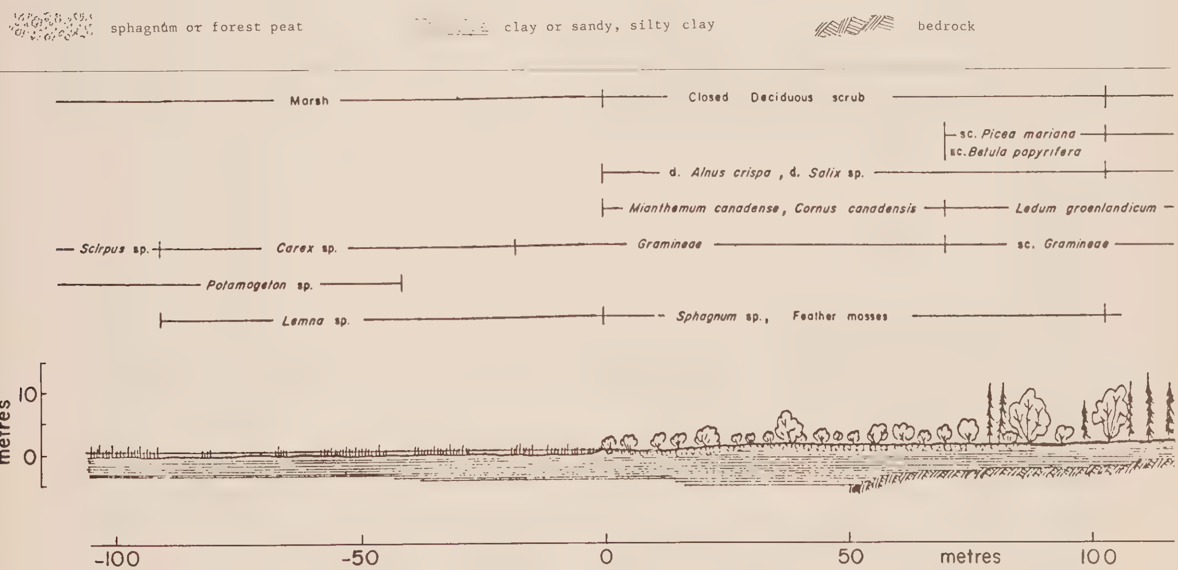
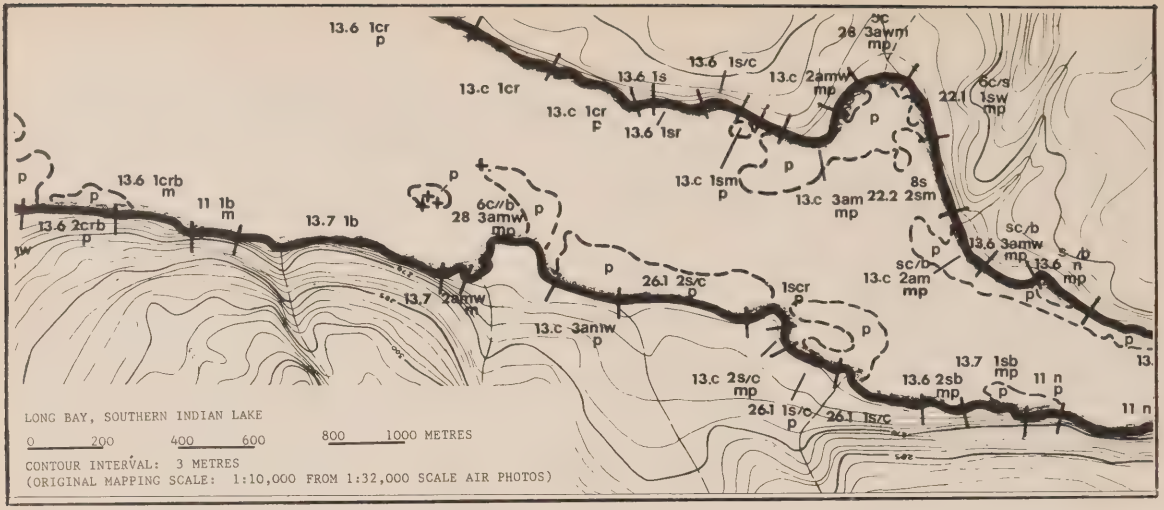


Figure 1: Shoreline Type 28



EXAMPLE

shoreline type — 13.6
shoreline type subdivision — 6
bank and adjacent uplands — s/b
beach — 3sw
offshore — mp

Gently sloping (6) bedrock-controlled shoreline (13); bedrock under shallow sand deposit (s/b); wide (3) beach of sand (s), with willow or alder scrub (w); offshore emergent (m) and floating (p) marsh vegetation.

SHORELINE TYPES

Bedrock

- 11 steep bedrock shoreline
- 13 bedrock-controlled shoreline

Overburden

- 22 shoreline in coarse (glacio-fluvial, pro-glacial) sediments
- 26 shoreline in fine (glacio-lacustrine) sediments
- 28 shoreline in (Recent) alluvium

Organic deposits

- 31 organic shoreline

SHORELINE TYPE SUBDIVISIONS

Type 11 - bank slope

- 9 vertical

Type 13 - backshore material

- c deep, lacustrine clay over bedrock (gentle slope: <1:5)

Type 13 - general backshore slope

- 6 gentle <1:5
- 7 moderate 1:5 to 1:2

Type 22, 26 and 31 - height of bank to upland area

- n very low <1 m
- 1 low 1 m - 3 m
- 2 high 3 m - 15 m
- 3 very high >15 m

SHORELINE PHASE VARIABLES

BANK

Slope

- 5 horizontal - applicable only to low lying shorelines of Type 22, 26 or 31
- 6 gentle <1:5
- 7 moderate 1:5 to 1:2
- 8 steep >1:2
- 9 vertical

Stability

- x active erosion - slumping or bank undercutting

Materials (bank and adjacent uplands)

- b bedrock
- s sand, gravel (pro-glacial, glacio-lacustrine)
- a sandy, clayey silt (Recent alluvium)
- t clayey till
- c clay, varved clay and silt (lacustrine)
- o peat (deep organic deposits)

- x/y shallow deposit of x overlying y
- x//y deep deposit of x overlying y

BEACH

Width

- n not wide enough to interpret from aerial photo
- z in deep shadow - not interpreted
- 1 narrow <3 m
- 2 wide 3 m - 15 m
- 3 very wide >15 m

Materials

- b bedrock
- r boulders, cobbles
- s sand
- a sandy, clayey silt, sometimes gravelly. (Recent alluvial deposits of small streams, occasionally widespread littoral deposits)
- c clay, silty clay, sandy clay
- o organic matter

- xy in combination, x predominant
- x/y thin layer of x overlying y

Vegetation

- D deciduous trees
- M mixed deciduous and coniferous trees
- w shrubs - willow or alder
- m marsh vegetation

Note regarding Type 28: The whole of the low alluvial flat is treated as if it were beach. The description of bank slope and materials thus referes to the edge of the adjacent landform.

OFFSHORE

- m emergent, standing marsh vegetation
- p floating vegetation

Where stands are of sufficient extent they are demarcated by a dashed line.

- \+ rocks, reefs

Where bank, beach or offshore characteristics are not indicated, assume that they occur as shown in the Shoreline Type description.

Figure 2: Revised Shoreline Classification Legend and example of mapping for Long Bay Southern Indian Lake, Manitoba.

outcrops, can be mapped only with some indirect interpretation at an aerial photographic scale as small as 1:32,000. Accurate description of shoreline vegetation zones requires a larger scale. In the Long Bay mapping project, illustrated in Figure 2, units as short as 50 m were demarcated, entailing a base map scale of 1:10,000. This is the scale of the land phase as described by Jurdant et al (1977), but the shoreline phase should not be considered precisely analogous to the land phase unless actual communities and dominant species of the zones of vegetation are mapped. Nearshore vegetation on Long Bay will be mapped in the 1978 field season and incorporated into the phase level of the classification system.

REFERENCES

Jurdant, M., J.L. Belair, J.P. Drucru and V. Gerardin. 1977. La cartographie écologique intégrée du territoire de la Baie James, pp. 172-199 *in* Proc. 1st meeting Can. Comm. Ecol. Land Classif. (comp. and ed. by J. Thie and G. Ironside). Ecological Land Classification Series No.1, Lands Directorate, Environment Canada, Ottawa.

Lake Winnipeg, Churchill and Nelson Rivers Study Board. 1974. Hydrologic,Hydraulic and Geomorphologic Studies. Technical Report, Appendix 2, Vol. 1.

Newbury, R.W., S. McLeod, G.K. McCullough, R.V. Oleson. 1973. Characteristics of Churchill-Nelson Shorelines. Interim Report to Lake Winnipeg, Churchill and Nelson River Study Board.

Newbury, R.W., K.G. Beaty and G.K. McCullough, 1978. Initial shoreline erosion in a permafrost affected reservoir, Southern Indian Lake, Canada. *in* Proc. Third International Conference on Permafrost, Edmonton, Alta. July.

Odum, E.P. 1959. Fundamentals of Ecology. W.B. Saunders Company, Philadelphia, U.S.A.

Shay, J., G.K. McCullough and C.T. Shay. 1978. Biomass and nutrient content of the flooded boreal forest in Long Bay, Southern Indian Lake, Canada. *in* Proc. Canadian Botanical Association Annual Meeting, St. John's, Nfld.

Subcommittee on Biophysical Land Classification. 1969. Guidelines for Biophysical Land Classification. Can. For. Ser. Publ. No. 1264.

ABSTRACT

A shoreline classification system developed for inventory of the Churchill and Nelson Rivers in Manitoba has been refined at Southern Indian Lake to facilitate extrapolation of data from current studies of shoreline erosion and nutrient input of the flooded biomass into the lake. The system described is hierarchical in nature. Six basic shoreline types describe different natural associations of geologic materials, shoreline morphology, and vegetation. These are subdivided on the basis of slope and bank height. Certain parameters descriptive of the bank, beach and offshore zone are mapped by means of alphanumeric coding. The shoreline types correspond to the land type proposed by the Subcommittee on Biophysical Land Classification (1969) and the latter parameters to the variables described at the scale of the land phase of Jurdant et al (1977).

RÉSUMÉ

Un système de classification des rives, mis au point pour les fleuves Churchill et Nelson au Manitoba, a été perfectionné lors de l'étude du lac South Indian, afin de faciliter l'extrapolation des données relatives à l'érosion des rives et à l'apport des éléments nutrififs à la végétation submergée. Le système est hiérarchique. Six catégories fondamentales de rives décrivent les différentes associations naturelles de matériaux géologiques, de morphologie et de végétation. Les types de rives se répartissent selon la pente et la hauteur des berges, les plages et la zone lacustre sont identifiés sur les cartes au moyen de codes alphanumériques. Les types de rives correspondent au type écologique du Sous-Comité de la Classification Biophysique du Territoire (1969) et les paramètres aux variables de la phase écologique de Jurdant et al (1977). (Trad. Éd.)

A COMPARISON OF FOUR LEVELS OF SOIL AND ECOLOGICAL MAPPING IN FORESTED WATERSHEDS*

D. E. Moon
Land Resource Research Institute
Agriculture Canada
Vancouver, British Columbia

INTRODUCTION

The British Columbia Ministry of Forests has long recognized the need for planning the use and development of forested land. They have defined four levels of planning: regional, management unit (Public Sustained Yield Unit), sub-unit (watershed), and operational (cut block) (B.C. Forest Service 1975). Attempts by Ministry of Forests personnel to use existing reconnaissance level soil and biophysical inventories for sub-unit planning have met with limited success, primarily because existing inventories were conducted at scales and using map units inappropriate to this level of planning. For the past three years, the British Columbia Pedology Unit of the Land Resource Research Institute, Agriculture Canada (L.R.R.I.) has been cooperating with the Forest Service, British Columbia Ministry of Forests to produce basic resource inventories for use in the *Resource Folio Planning System* (B.C. Forest Service, 1975) at the sub-unit planning level. This cooperation (specifically with the Vancouver Forest District) has led to a change in both the mapping units used and in the interpretations of these units requested by the Forest Service. This paper will outline our present program of soil and ecological mapping which compares four levels of inventory in the Mill Creek and Woodfibre Creek watersheds located 48 km north of Vancouver.

BACKGROUND

Our initial involvement came as a result of a Forest Service request to produce *terrain unit inventories* (ELUC Secretariat, 1976) for several watersheds in the Vancouver Forest District. It soon became apparent that Terrain Unit mapping, even at scales of 1:30,000, while providing an excellent first stratification did not supply enough information to meet forestry needs. Phasing of terrain units on slope and drainage criteria dramatically increases the utility of the inventories for making interpretations but still suffers from some serious limitations. Information lacking in this approach includes: 1) depth to or presence of compacted or indurated till; presence of cemented horizons; texture; and pattern of rock outcropping which influence many engineering interpretations, 2) depth, nature, and nutrient status of forest floor and sola; rooting depth and volume; and water storage capacity which influence silvicultural interpretations, and 3) vegetation and climatic zonation and plant communities used in silvicultural interpretations and wildlife habitat evaluation.

In addition to the information to be gathered, we were presented with the problem of interpreting our map units. The delineation of homogenous treatment units is considered very desirable by the users of these inventories. The presentation of mapping complexes, even documented as to pattern and distribution, presents planning problems at the cut block level. Unless the map units significantly reduce the number of probable treatment options they are of little use for office planning and are little more than a key for field identification. Furthermore, problem areas should be defined within fairly narrow spatial limits to aid in assessing proposed road locations and treatment boundaries.

NATURE OF INTERPRETATIONS

Since few users of resource inventories have the necessary background to develop interpretations on their own, we are producing a series of interpretive maps, each map presenting interpretive groupings for a fairly narrow range of uses or problems. Interpretive maps requested or provided to

* Abstract/Résumé on/a page 334 .

date fall into three classes: engineering or geotechnical, silvicultural, and management impacts on forest productivity or other resources. We are currently providing the following interpretive maps:

a) Engineering

1. *Inferred slope stability ratings* - providing ratings of potential mass movement as a result of natural conditions, timber removal, and road construction.

2. *Road associated problems* - providing ratings of potential cutslope failure or ravelling, fillslope failure or migration, and roadbed failure.

3. *Suitability for gravel and subgrade* - providing ratings for use as or source of gravel and subgrade materials.

4. *Suitability for tractor logging* - providing suitability ratings for different methods of tractor logging (rating system is not yet finalized but will include trafficability and operability criteria).

b) Silvicultural

1. *Preferred species composition* - listing preferred tree species and proportions for second rotation stands (following Klinka, 1977).

2. *Productivity classes* - providing relative ratings, site index, or mean annual increment depending on information available.

3. *Brush Hazard* - providing probability of brush species invasion retarding the establishment or growth of regenerating tree species.

c) Management impact on productivity or other resources

1. *Surface movement* - providing ratings of potential surface creep or ravelling inhibiting the establishment or causing the loss of regeneration. The ratings are established with respect to harvesting, harvesting and burning, and cutslope ravelling or failure as a result of road construction.

2. *Slash burning* - rates the maximum intensity of slashburn which will not significantly reduce site productivity.

3. *Potential sediment yield* - lists probability of significant sediment yields as a result of surface erosion, road construction, and mass movement following or during harvesting (rating system not finalized).

4. *Environmental protection areas* - showing areas where harvesting using present methods will cause irreversable site damage.

MILL AND WOODFIBRE CREEKS PROJECT

Objectives

The B.C. Pedology Unit undertook the inventory of Mill and Woodfibre Creeks to meet the following objectives:

1. To assess the utility and reliability of three different scales of mapping for detailed forest planning.

2. To determine appropriate scales and methods of soil or ecological inventories for different levels of forest planning.

3. To develop methodology and mapping units for intermediate and large scale inventories suitable for forestry needs.

4. To assess the compatability of augmenting large scale soil maps with small scale inventories from other agencies and vice versa.

5. To produce a detailed soil map as a planning and interpretive base for a sensitive watershed in forested mountainous terrain.

The Study Area

The two watersheds under study provide water for the Rayonier of Canada pulp and paper mill at Woodfibre, approximately 48 km north of Vancouver. Covering a total of 65 km^2, the Mill and Woodfibre Creek watersheds are small enough to allow detailed inventory of productive forest land to be conducted in a reasonable time but large enough to contain most landscape and soil features represented in south coastal British Columbia. The critical water quality requirements of the pulp and paper operation require stringent

operational control to ensure maintenance of water quality and thus justify a detailed inventory for the area.

Inventory Phase

To provide a realistic comparison of mapping approaches this inventory is being conducted in five stages. Each stage is, when possible, completed before the next stage is undertaken.

1) Following an initial reconnaissance, soil associations were pretyped on 1:31,680 aerial photographs augmented with 1:63,680 scale aerial photographs. Time and access for field verification was consistent with routine inventory procedures. Boundaries and map unit descriptions will remain unchanged despite more detailed study.

2) Following completion of the first stage, terrain units were pretyped on 1:31,680 aerial photographs. Field verification and retyping was conducted coincident with reconnaissance for the detailed soil mapping but was suspended when time and access were consistent with routine inventory. Again, boundaries and map unit descriptions will remain unchanged.

3) Typing, verification, relocation of boundaries ,and final legend production for the detailed inventory is in progress and we expect completion by September 1978. In addition, biogeoclimatic subzone boundaries will be determined at a scale of 1:31,680.

4) Following completion of stage three, modal sites will be described,sampled, and analysed for the three levels of mapping.

5) Detailed transect studies in a completed portion of the watersheds will also be conducted in the current field season. These will be used to assess within and between map unit variability as well as the legitimacy and reliability of boundary locations at the detailed level.

Nature of Map Units

Map units at the smallest scale (1:50,000) will follow the *Soils of the Tulameen Area of British Columbia* (Lord and Green, 1974) in which map units are identified as catenary sequences named after the dominant soil and further stratified on the basis of subordinate soils occuring in the catenary sequence. Accessory information included in the map symbol will be slope class, and unlike the soil ratings in the Tulameen area, the biogeoclimatic subzone allocation (Krajina, 1969) and ratings for fish, wildlife, and recreation will be taken from independent inventories conducted by the Fish and Wildlife Branch, British Columbia Ministry of Environment and the Recreation Division of the Forest Service, British Columbia Ministry of Forests.

The intermediate scale (1:31,680) map units will follow standard Terrain Unit criteria with the addition of the biogeoclimatic subzone as accessory information in the map symbol. Cartographic considerations will require the use of a numerical legend rather than full terrain unit symbology on each map delineation.

The largest scale (1:15,840) will use soil associates as the basic mapping unit which will be defined on the basis of the *Canadian System of Soil Classification* soil subgroups, drainage class, and family texture class further identified as to angular or rounded coarse fragments (Canada Soil Survey Committee, CSSC, 1978). Accessory information to be presented in the map symbol will consist of the biogeoclimatic subzone and edaphatopic grid reference (Krajina, 1969), slope class, terrain unit surface expression and modifying process and CSSC family depth classes applied to potential rooting depth in both lithic and non-compacted over compacted till soils. The depth and kind of forest floor, the complete terrain unit symbol and additional features of management importance will be included in the legend.

Where scale does not permit delineation of single associate map units, soil associations or complexes will be identified. Soil associations will follow the United States Department of Agriculture (1962) definition. Complexes will be named map units based on the pattern and distribution of member associates.

Cartography and Interpretive Maps

Cartography and printing will be handled by the Cartography Unit of the Land Resource Research Institute in Ottawa. Maps will be digitized and symbolized. Following digitizing and final proofing of the soil maps, a series of computer-generated, derived and interpreted maps will be produced on a computer plotter. These will include biogeoclimatic subzones; ratings for fish, wildlife and recreation; and interpretive maps consistent with the level of inventory used. The 1:15,840 soil map will be used to generate a 1:31,680 terrain unit map and a 1:50,000 soil map for comparison with the original maps to determine the reliability, precision, and validity of the original units.

In addition the 1:15,840 soil map will be used to generate a 1:31,680 soil association map for use as a comparative planning base.

Application and Follow-up

The soil associate map and a complete set of interpretive maps at 1:15,840 will be used as a base to establish management and operational guidelines for the development of the watersheds. In addition the 1:50,000 soil map, the 1:31,680 terrain unit/biogeoclimatic subzone map, and the 1:31,680 soil association map will be presented together with selected interpretive maps for evaluation with respect to different planning needs. As development of the watershed proceeds, follow up work will be done to assess the reliability and validity of the detailed soil units recognized and the interpretations assigned to them. In addition, the utility of the map units as a base for establishing and maintaining operational control guidelines will be assessed.

SUMMARY

In summary, we will present four approaches to soil and ecological inventory for use in forest planning. A report outlining methods of inventory and the nature of both mapping and map units will be published together with the methods and criteria used in developing the interpretive maps. The reasons for, and the implications of, discrepancies between the original 1:50,000 and 1:31,680 maps and the computer generated maps of the same scales will be discussed. Finally, an evaluation of the utility of each approach for planning at various levels will be done by Ministry of Forests personnel involved in planning the development of the watersheds and included in the report.

REFERENCES

Agriculture Canada. 1976. Glossary of Terms in Soil Science Publ. No. 1459 66 p.

British Columbia Forest Service. 1975. Forest Resource Planning in British Columbia. A brief submitted to The Royal Commission on Forest Resources.

Canada Soil Survey Committee. 1978. The Canadian System of Soil Classification. Agriculture Canada Publ. No. 1646.

ELUC Secretariat. 1976. The Terrain Classification System. Victoria, B.C.

Lord, T.M. and A.J. Green. Soils of the Tulameen Area of British Columbia. Agric. Can. Report No. 13. British Columbia Soil Survey.

Klinka, K. 1977. Guide for Tree Species Selection and Prescribed Burning in the Vancouver Forest District. Second Approx. Province of British Columbia, Ministry of Forests.

Krajina, V.J. 1969. Ecology of Forest Trees in British Columbia. *in* Ecology of Western North America, Vol. 2 No. 1. Dept. of Botany, University of British Columbia.

United States Department of Agriculture. 1962. Soil Survey Manual. USDA Handbook No. 18.

ABSTRACT

A program of soil and ecological mapping comparing four levels of environmental inventory in two watersheds near Vancouver, British Columbia is outlined. Interpretive maps dealing with geotechnical, silvicultural, and management impacts on forest productivity are discussed and the utility of each approach to planning is examined. (Ed. Abstr.)

RÉSUMÉ

Le présent rapport met en vedette un programme de cartographie et pédologique qui compare quatre échelles d'inventaires appliqués à deux bassins hydrographiques près de Vancouver. On y discute de cartes d'interprétation relatives aux incidences sylvicoles, géotechniques et gestionnelles sur la productivité des forêts. De plus, on y étudie l'efficacité de chacune des approches du point de vue de la planification. (Rés. Éd.)

THE USE OF ECOLOGICAL INFORMATION IN SETTLEMENT PLANNING — A CASE EXAMPLE*

A. L. Quin
Planning Services
Municipal Affairs
Ministry of Municipal Affairs and Housing
Victoria, British Columbia

INTRODUCTION

This paper addresses the question of the application of biophysical mapping to settlement planning in the context of recreational lot, rural residential, urban fringe and urban development. Special emphasis is placed on the need and demand for a wide range of mapping applications in light of new legislation pertaining to regional, settlement and community planning within the Province of British Columbia. Biophysical mapping prepared for the Tumbler Ridge townsite project in the northeast coal block area of the Province is used as a case example. A wide range of biophysical interpretations have been applied and utilized in selecting a townsite location and in preparing the conceptual design for a new townsite. No attempt has been made to describe in detail the wide range of interpretations inherent in any one type of classification system. The biophysical interpretations are, however, treated in general terms as to usefulness and application in a settlement planning context.

LAND USE PLANNING CONTEXT

In the last few years a wealth of biophysical, as well as social and economic information has been generated through reconnaissance mapping in both the northeast and southeast regions of the province for the purposes of providing a resource base to assist in making both settlement and resource land use decisions. Much of this information has been provided by provincial ministries in a cooperative program of inventory and analysis in response to proposed new and expanding coal mining developments within the two regions.

Biophysical mapping of the terrain and natural resources has been particularly useful to both public and private interest involved in the planning of settlements. For instance, in the northeast region of the province, biophysical mapping has been used in the selection of townsites as well as in development of concepts for planning of a new settlement.

The coordinated and cooperative mapping of a wide range of biophysical parameters such as natural hazards, terrain suitability for settlement and other parameters, will be particularly useful to a number of users. Presently land use planners, subdivision approving officers, regional district technical planning committees, and others who are required to advise on land use issues for provincial, regional and local governments as well as private industry receive on request biophysical mapping at various scales, and interpretations from various sources. As the availability of resource information is important to the potential users and as there are a number of agencies involved in data collection and interpretations, coordination is required to bring this information to a standard that is useful in settlement land use decision making. This is of crucial importance, particularly in light of recent amendments to the Municipal Act of British Columbia (September 1977), which have put increased demands on regional districts and municipalities to prepare regional, settlement and community plans, and which address the ecological/physical environment of settlement. In fact, the new legislation requires policy attention to biophysical concerns.

CHANGES IN PLANNING LEGISLATION IN BRITISH COLUMBIA

A biophysical mapping program is essential to Regional Districts and municipalities in their preparation of official plans. The amendments to the Act specifically 'spell out' the required content of both official community and settlement plans. The Act requires the following

* Abstract/Résumé on/à page 344.

I - a statement of broad social, economic and environmental objectives to be achieved by implementation of the plan

II - a statement of the policies of the Regional Board respecting the general form and character of the future land use pattern within the area covered by the plan including:

1) the location, amount and type of major commercial, industrial, institutional, recreational and public utility uses;

2) the location, amount type and density of residential development required to meet the anticipated housing needs over a period of at least five years in the area covered by the plan;

3) the protection of land areas subject to hazardous conditions;

4) the preservation, protection and enhancement of land and water areas of special importance by reason of scenic or recreational values or natural, historical, or scientific interest;

5) the preservation and continuing use of agricultural land for present and future food production;

6) the proposed sequence of urban development and redevelopment, including where ascertainable the proposed timing, location and phasing of trunk sewer and water services;

7) the need for and provision of public facilities including schools, parks and solid waste disposal sites;

8) the location in schematic form of a major road system to serve the area covered by the plan;

9) the location, amount and type of development to be permitted within 1 km of a controlled access highway designated under the *Controlled Access Highways Act;*

10) the distribution of major land use areas and concentrations of activity in relation to the provision of existing or potential public transit services; and

11) a program identifying the actions required by the Regional Board to implement the official settlement plan

In the preparation of the official community and settlement plan, consideration shall alsc be given to:

a) the probable social, environmental and economic consequences of proposed policies;

b) the stated objectives, policies and programs of the Government;

c) the suitability of land for various uses;

d) land area requirements for various uses related to projections of population and economic growth; and

e) the prevention of pollution of air, water and land.

In summary, the Act is explicit in requiring environmental objectives, policies relating to biophysical concerns, and emphasis on consideration of the environmental impact of proposed policies.

The response to the new legislation has been very positive as can be interpreted in the following table.

Table 1: Status of Regional and Community Planning Programs as of Spring, 1978.

Plans	In Place Prior to Sept/77	Being Considered *	Under Preparation/ Revision *
Official Regional Plans	15	1	3
Official Settlement Plans	—	16	36
Official Community Plans	20	21	21

*Preliminary estimates - March 15, 1978

Similarly, since the new legislation has been passed there is an apparent demand for terrain suitability analyses to be undertaken in communities, urban expansion areas and rural settlement areas. Seventeen out of 28 Regional Districts made request submissions

to the Ministry of Municipal Affairs and Housing for general urban suitability analyses for 31 project areas. Unfortunately, due to manpower constraints and demands for services from other Ministries, the Resource Analysis Branch of the Ministry of the Environment, the prime provider of this information, could only accommodate a minimal number of project requests. Until such time as Regional Districts and member municipalities have the resource capabilities - staff expertise and finance - to prepare the biophysical inventories and analysis, the provincial government will be looked upon as an information resource. In order to meet the demand, coordination and cooperation of provincial programs as well as the rethinking of mapping methodology (in terms of reducing the time, expense and level of information generated) would be useful.

It is clear that there is a need and demand for biophysical information. The key question remaining is how the information can be used in land use planning. The Tumbler Ridge project is used as a case example to show how a broad range of biophysical inventories and analyses were used in determining and evaluating alternative townsite locations as well as in the preparation of a concept townsite development plan. The biophysical studies are identified with a brief description of their application within a land use planning context. General conclusions are drawn as a result of this discussion that may be useful for ongoing inventories and analysis in other areas of the Province.

TUMBLER RIDGE TOWNSITE PROJECT — A CASE EXAMPLE

Since 1976 a number of studies have been undertaken by the Province as part of the Northeast Coal Development Study, one of which was the site selection and conceptual design of a new townsite at Tumbler Ridge, southwest of Dawson Creek, British Columbia. The map in Figure 1 identifies the regional location of the townsite and its geographical relationships to the proposed mining areas.

The site selection and preparation of alternative conceptual designs of the new townsite were the responsibility of the Townsite/Community Development Subcommittee on Northeast Coal, one of 5 Subcommittees responsible to reporting to the Provincial Cabinet Coal Committee and responsible for various aspects of the proposed coal developments. The other committees were concerned with evaluation of the coal resource, supply and demand for labour, transportation and communication planning and overall environmental aspects of proposed coal developments.

The townsite design concept incorporated within this report, is one of several that have been evaluated for this particular site. For discussion purposes, the townsite layout has been simplified. It should be noted that in the design of alternative concepts social, environmental and physical planning concerns have been given equal consideration in the planning process, for example in defining the spatial relationships of neighbourhoods to the town centres as well as the phasing of development in the neighbourhoods and town centre. In terms of the physical plan, particular emphasis is given to the biophysical design constraints and opportunities that have been interpretated in formulating a townsite land use concept.

Site Context

The townsite location at Tumbler Ridge is somewhat unique to the region in terms of its inherent natural features and resources and as such offers a challenge for townsite planners to design a town that is sensitive to the natural environment. The site location for townsite development is considered to be the area lying to the east of the Murray River. Three principal fluvial or glaciofluvial terraces exist on this site, the upper terrace being approximately at an elevation of 830 metres with site aspect to the south and west. The succession of terraces terminates at the base of Tumbler Ridge — a prominent escarpment consisting of bedded sandstone and shales. Variations of tree cover are evident on the terraces at Tumbler Ridge, ranging from aspen parkland in the southwest area to mature spruce and pine on the upper benches, and lodgepole pine and spruce mix in the southeast. The mix of deciduous trees enhance the visual attrac tiveness of the site during spring and fall.

Slope failures and minor mud flows are evident along the river bluffs of the Murray River from the confluence of and downstream from Flatbed Creek. The floodplains of the streams, the river bluffs, and the lower terraces serve as a high capability winter range for moose, elk, deer and caribou. In addition to its high capability for winter range, the Murray River floodplain serves both as summer range and a migration corridor by ungulates.

The Murray River is also recognized as being an important spawning and rearing stream for

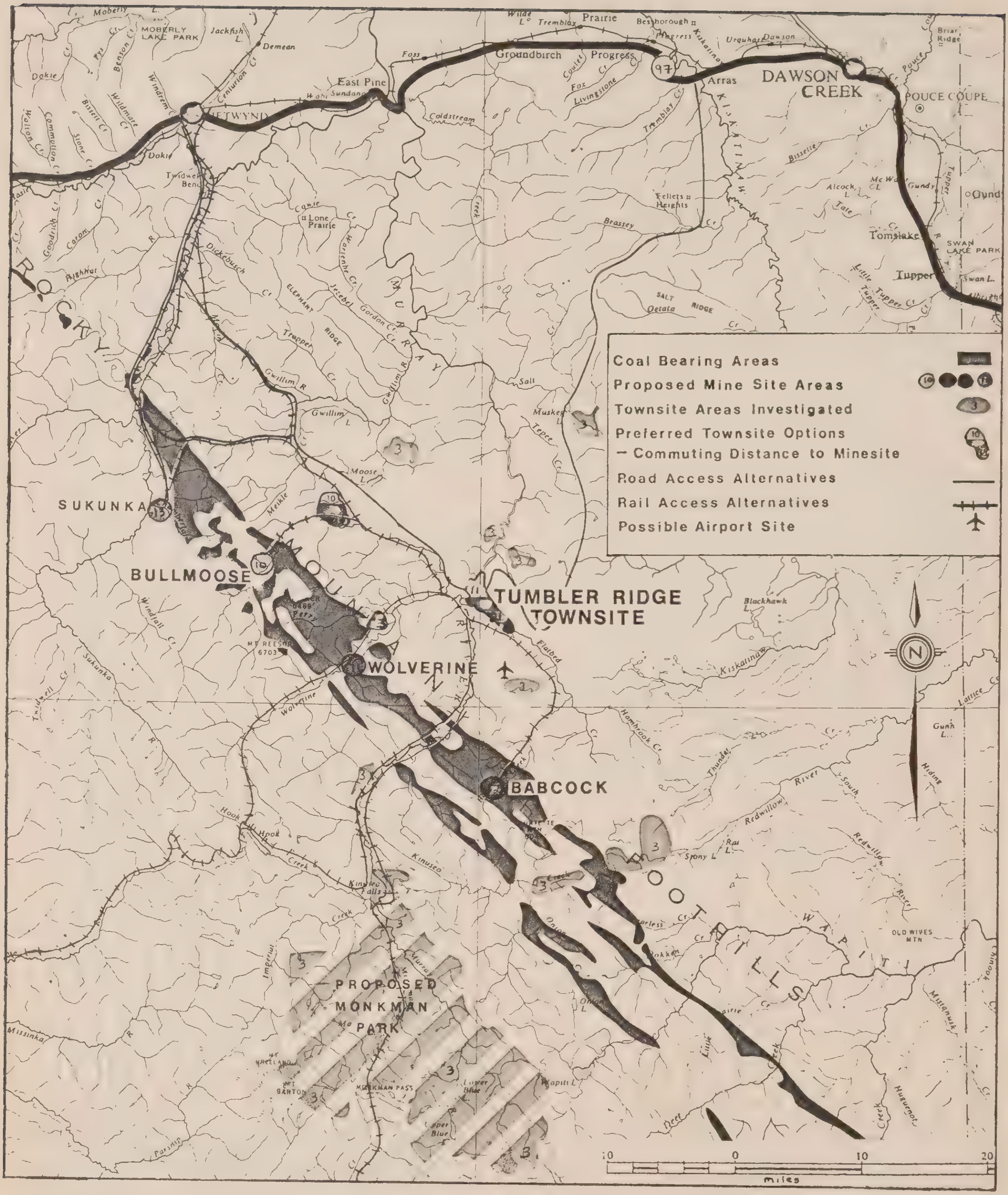


Figure 1: Location of Tumbler Ridge Townsite within Northeastern Coal Block Study Area near Dawson Creek, British Columbia.

Arctic grayling and whitefish. Flatbed Creek and Wolverine River possess lower fishery values than the Murray River; however both are considered to have high fishery capability.

The slopes and steep bluffs of Tumbler Ridge and the bluffs along the Murray River at Flatbed Creek offer views of Mount Bergeron, Mount Spieker Range and the valleys of Flatbed Creek, Murray and Wolverine Rivers.

Site Constraints and Opportunities

The site development constraints, the community design and resource opportunities are graphically displayed on the Figure 2 map. In order to bring forth both the site constraints and opportunities into a land use planning context, Table 2 briefly describe the biophysical studies undertaken and the planning response to them. Mapping of the site features, as listed in this table, fall into the following general categories: natural hazards, resources sensitive to development, terrain suitability for settlement and community design and resource opportunities. In analysing the resource information, some of the constraints to townsite development are made explicit. Snow avalanche potential, streambank stability, flooding and inundation are physical constraints that generally define the townsite development area. Additional man-made constraints are certain future land uses such as the proposed location of the exfiltration sewage disposal site, the provincial highway right-of-way and offsite water supply. These also modify the location and extent of the townsite development area.

The general townsite development area boundaries had been defined somewhat by both biophysical and potential man-made constraints. However, further biophysical analysis of the development area was required to determine the area most suitable for development. Slope and stability of terrace escarpments, poor drainage areas, and vegetation were the main physical constraints parameters requiring particular attention. The nature of indigenous vegetation, the location and stability of terrace escarpments, as well as the microclimate were the most important biophysical features considered in designing the townsite. The soils on the site by their nature offer few constraints to development, particularly the terraces south of the highway. Previous forest fires, soils, hydrology and microclimate of the site together have resulted over time in a variety of vegetation patterns which offer design opportunities. South and southwest prevailing winds blowing across the three major terraces result in wind-formed vegetation creating an opportunity for linear wind breaks that generally run north and south.

An Alternative Design Concept

A number of alternative townsite design concepts have been considered for the Tumbler Ridge site location, one of which is schematically portrayed on Figure 2.
Although there are a number of social design objectives built into the design concept, those objectives are not dealt with in this document. Social considerations for instance have been considered in terms of the spatial relationships of those elements of the physical plan layout that have strong social connotations — such as the location of recreation and open space, the relationship of neighbourhoods to the town centre, the type and tenure of housing, and the location of community services. The emphasis in discussion is therefore on the physical plan and its response in design to the natural environment.

The proposed alternative townsite plan concept has been particularly sensitive in its design to natural hazards, man-made constraints, resources sensitive to development and resource opportunities. The main development area is proposed for the upper bench away from the main streams and their floodplains and lower slopes of Tumbler Ridge; thereby minimizing the direct impacts of townsite development on the important aquatic resources and wildlife habitations. The proposed locations of transportation linkages and offsite water and sewer system facilities have been determined with sensitivity to natural hazards and wildlife and aquatic values.

Within the townsite development area, vegetation is proposed to be retained on the scarp for the purpose of forming windbreaks in a linear form along the top of the scarp in a north/south orientation. These natural windbreaks offer useable open space buffers between neighbourhoods, provide natural parkways throughout the site linking activity areas, as well as offering pedestrian comfort and energy savings during the five winter months. Major arterial roads run, where possible, along the base of the terrace scarps in order to retain as much land as possible for residential, institutional and commercial use in the wind shadow areas. Low density residential development is located on gently sloping land where individual trees can be selectively retained. Higher density residential uses are proposed where the saving of groups of trees is more appropriate and where topography dictates higher density uses.

Table 2: Tumbler Ridge Townsite - Constraints and Resource Opportunities

TOWNSITE AREA MAPPING		SOURCE OF INFORMATION			
GENERAL DESCRIPTION	DETAILED STUDIES	RECONNAISSANCE	DETAIL	GENERAL INTERPRETATIONS	PLANNING RESPONSE
I. DEVELOPMENT AREA CONSTRAINTS					
A. Hazard Mapping	1. Streambank stability.	Geotechnical Materials Branch (Ministry of Highways and Public Works)	Consultants Resource Analysis Branch	The landslides that have produced the scarp along the Murray River and Flatbed Creeks are classified as active, inactive or stabilized. Setback requirements were recommended.	No permanent structures should be permitted within the setback zone, particularly those uses which would allow infiltration into the ground.
	2. Snow avalanche potential.	Ministry of Highways and Public Works		Assessment of snow avalanche potential on the slopes of Tumbler Ridge. Minor snow avalanche areas and runnout zones identified.	Reduce future risk of extending hazard area by imposing logging controls on the slopes of Tumbler Ridge.
	3. Flooding and Inundation potential.	Water Investigations Branch (Ministry of the Environment) Resource Analysis Branch (Ministry of the Environment)		The flooding hazards of the Murray River, Flatbed and Wolverine Creeks were evaluated by the use of air photo interpretation in conjunction with an investigation of the terrain and hydrologic characteristics. Mapping differentiates areas that are flooded frequently, occasionally and rarely.	Structures and activities associated with townsite development on the floodplain should be limited and compatible with the hydrologic regime.
	4. Forest fire potential.	Resource Analysis Branch (Ministry of the Environment)	Consultants	Past forest fire history and site vegetation types were evaluated.	Alternative forest management strategies proposed in order to reduce the forest fire hazard risk in the proposed settlement area.
	5. Sour gas hazard.	West Coast Transmission		100 and 500 ppm isopleth zones of SO_2 concentration resulting from a break within the proposed Grizzly Gas Pipeline located to the south of the townsite were determined.	In order to reduce the health hazard risk in the event of a pipeline rupture, additional safety valves will be added to the proposed gas line. The 100 ppm isopleth now lies well outside the townsite boundary.
B. Resources Sensitive to Development	1. Aggregate resources.	Geotechnical Materials Branch (Ministry of Highways and Public Works) Resource Analysis Branch (Ministry of the Environment		Fishery habitat of the river systems was evaluated in terms of fish species and relative values. Fish habitat zones were derived from the potential flooding map and broken down into active, semi-isolated, isolated and ephimeral channels. The fish species found within the major streams are abundant for sports fishing.	Habitat variability is the key to the high fishery productivity within the streams; therefore major alterations for example actions to stabilize the stream banks should be minimized.
	2. Aquatic habitat.	Resource Analysis Branch (Ministry of the Environment		Fishery habitat of the river systems was evaluated in terms of fish species and relative values. Fish habitat zones were derived from the potential flooding map and broken down into active, semi-isolated, isolated and ephimeral channels. The fish species found within the major streams are abundant for sports fishing.	Habitat variability is the key to the high fishery productivity within the streams; therefore major alterations for example actions to stabilize the stream banks should be minimized.
	3. Wildlife Habitat.	Resource Analysis Branch (Ministry of the Environment)		The townsite area is an important unit of winter range for moose, elk and deer and because of its location at the confluence of four major rivers, serves also as an avenue of travel by animals to and from their seasonal ranges. An ungulate capability map was drafted to indicate a true measure of the importance of the habitat to ungulates.	Direct impacts from townsite development on Murray River and Flatbed Creek floodplains, south facing river escarpments, and lower slopes of Tumbler Ridge should be minimized. Both wildlife and fishery values within the Murray River floodplain as well as visual resource values have been an important consideration in the relocation of the provincial highway to its present proposed location.
	4. Heritage Resources.	Resource Analysis Branch (Ministry of the Environment)		Some evidence exists of historic settlement by both Indian and white groups near the mouth of Flatbed Creek and Bullmoose Creek.	Archeological sites of significance should be protected -- failing this the area should be surveyed for possible artifacts prior to intrusion.
C. Terrain Suitability for Settlement		Geotechnical Materials Branch (Ministry of Highways and Public Works) Resource Analysis Branch (Ministry of the Environment)	Consultants	Airphoto interpretations of the townsite terrain in conjunction with auger and drill log analysis were used to determine the engineering suitability for construction of roads and buildings up to four stories, as well as suitability for septic tank filter fields, playgrounds. Soil surface erosion and mass movement potential were also evaluated for the general area.	Granular soils which form most of the foundation soils in most of the proposed townsite area should present no significant limitations for commercial and residential use. Septic tanks would operate satisfactorily. Spread footings would generally provide suitable foundations. Slope and drainage limitations are found in isolated areas below the proposed provincial highway. Topographic breaks between successive benches from the lower slopes of Tumbler Ridge towards the river creates natural constraints.

Table 2 (cont.): Tumbler Ridge Townsite - Constraints and Resource Opportunities

TOWNSITE AREA MAPPING		SOURCE OF INFORMATION			
GENERAL DESCRIPTION	DETAILED STUDIES	RECONNAISSANCE	DETAIL	GENERAL INTERPRETATIONS	PLANNING RESPONSE
II. COMMUNITY DESIGN AND RESOURCE OPPORTUNITIES.	1. Climate.	Resource Analysis Branch (Ministry of the Environment) Consultants		Availability of climate information for interpretative analysis is severely limited by the number of years of recorded information. On a comparative basis relative to Dawson Creek the townsite is slightly cooler in summer but milder in winter. Total precipitation is estimated to be slightly higher than Dawson Creek. Preponderance of wind is from the south to southwest.	Townsite design should respond to wind direction, sun shadow, snow conditions and cold air drainage off Tumbler Ridge and snow conditions utilizing topography and natural vegetation.
	2. Vegetation.	Resource Analysis Branch (Ministry of the Environment)	Consultants Resource Analysis Branch (Ministry of the Environment)	Site vegetation types were evaluated in terms of visual density, sound absorption, significant plant species, stand wind resistance and plant species used by wildlife.	The aesthetic attractiveness of the stands and understory vegetation on the upper and lower bench areas could be used to advantage. Clumps of pine, spruce and aspen could be saved and retained on the scarp edges as wind breaks to insure protection from the south and southwest prevailing winds. Wider spacing of tree cover on the upper bench would allow for a more developed shrub layer making the site more interesting and suitable for open space or park use.
	3. Recreational amenities.	Resource Analysis Branch (Ministry of the Environment) Consultant		Assessment of the demand and supply for outdoor recreation, both within and outside the town. The most significant recreation features near the townsite are the Murray River (fishing, canoeing and boating), Murray River Floodplain (nature study, picnicing and camping), Flatbed Creek Meadows (fishing and viewing), Tumbler Ridge (viewing of valley scenery, hiking, picnicing).	Both the regional and local recreational use of the recreation facilities and opportunities should be incorporated into a master recreation plan for the proposed townsite residents. The floodplain on the west side of the Murray River, Flatbed Creek meadows should be designated as parkland. Tumbler Ridge should also be designated as parkland and left in its natural state. Recreational trails planned within the townsite should provide access to trails and recreational amenities near the town.
	4. Visual resources.	Resource Analysis Branch (Ministry of the Environment)		On the periphery of the townsite development area, the nature of topography and water bodies continue to create a variety of landscapes. Vegetation cover and scenic values to the south and Mt. Bergeron to the northwest contribute to the attractiveness of the landscape viewed from the townsite.	Townsite design should attempt to take advantage of the visual resources as much as possible, particularly the town centre, the foci of community activity offers the most potential.
III. POTENTIAL MAN-MADE CONSTRAINTS ON DEVELOPMENT. A. Offsite Services.	1. Water supply alternatives.	Water Investigations Branch (Ministry of the Environment)	Consultants.	Three possible water supply alternatives were investigated and concept designs of facilities proposed. Alternative sources included Quality Creek dam, Flatbed Creek aquifer and an infiltration gallery on Flatbed Creek.	Selection of a water supply system has been deferred until additional short term water quality and quantity information has been obtained. Evaluation of capital and operating cost, flexibility of the system to handle incremental townsite growth, impacts on proposed landscape as well as fishery and wildlife resources are water source facility selection considerations.
	2. Sewage disposal.	Pollution Control Branch (Ministry of the Environment)	Consultants.	Two alternative locations for waste water treatment and disposal facilities were identified and evaluated on the middle and lower terraces. Conceptual design and investigation of capital and operating cost for the two alternative treatment and disposal facilities was undertaken.	The aerated basin and exfiltration system proposed for the middle bench location is the preferred option from an environmental as well as a capital and operating cost view point.
B. Transportation.	1. Road and Rail corridors.	Transportation Sub-committee on Northeast Coal.	Consultant.	Alignments of the proposed provincial highway negotiated. Rail shunting yard location and associated industrial development identified.	Road network design to be cognizant of traffic generation from homesite to work place through the use of personnel, company and public transportation modes.

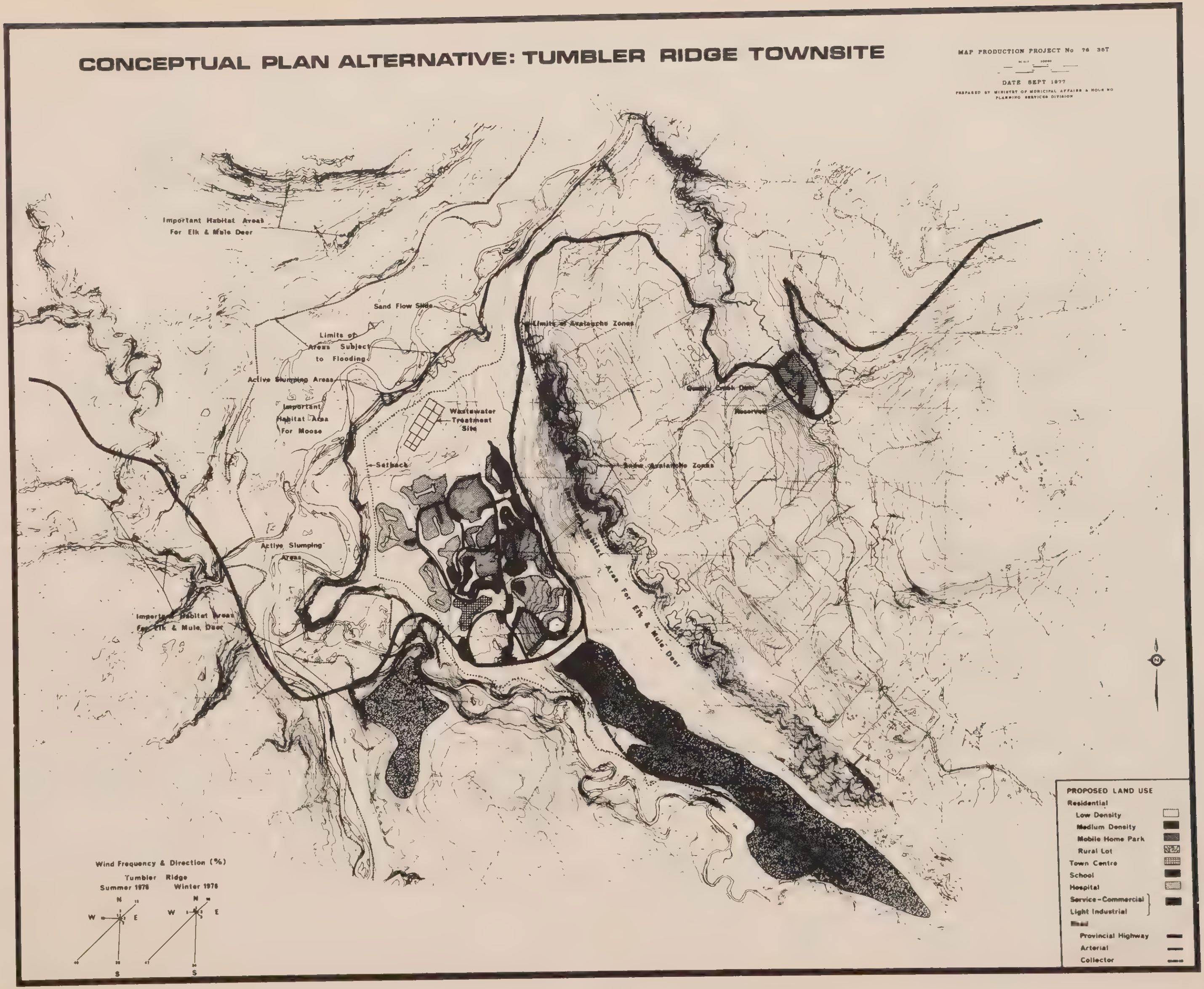


Figure 2: Conceptual Plan Alternative for Tumbler Ridge Townsite, British Columbia.

The town centre, the focus of community activity, is located at the south end of town at the terminus of the wind breaks. Open space linkages within the townsite focus on the town centre, which is in close proximity to other resource opportunities or amenities such as the outdoor recreation activity areas on Flatbed Creek and Murray River and the visual resources to the south. Open space networks will hopefully by their design encourage activities between the residential communities, the town centre and the wilderness beyond. The topography adjacent to the town centre is varied and offers visual horizontal relief as well as allowing better use of the land for higher density residential use.

Secondary activity to the town centre, such as schools and playgrounds have been located in the wind shadow areas adjacent to the windbreak.

Areas deemed unsuitable for residential development have been incorporated in the open space network as part of the buffers between neighbourhoods or as natural parks within neighbourhoods. Natural parks within neighbourhoods are particularly beneficial for use by young children in that they offer a new wilderness experience without them having to go to the fringe of town.

Major arterial and collector roads have been located at the base of the terrace scarp. The number of collectors running perpendicular to the scarps has been minimized in order to reduce the amount of earthworks and road maintenance as well as visual impacts.

A number of options for both offsite sewer and water facilities have been identified and evaluated in terms of capital and operating costs, flexibility in terms of staging in response to town growth and potential conflicts with other potential land uses, as well as environmental impact. The preferred method for sewage disposal is an aerated basin and exfiltration system proposed to be located on the second bench north of the settlement area. Vegetation buffer strips between the proposed site and settlement as well as along the Murray River terraces are preferred.

The decision on the water supply source is more complicated — additional water quantity and quality information of the options is required before a decision is made. However, a groundwater source if feasible is preferred because the capital and operating costs are much lower and the staging capabilities of the system are more flexible while the environmental impacts are minimal.

The proposed location for the groundwater source is identified on Figure 2. Major constraints on this system are potential gravel resource mining and rural residential development.

CONCLUSIONS AND RECOMMENDATIONS

It can be generally stated that there is need for environmental information as a basis for the planning of human settlements that can be used in a settlement land use planning context. Given the recent amendments to the Municipal Act and given the positive response to the new legislation by regional districts and municipalities, there is likely to be increased demand for reconnaissance level and site specific environmental information. Presently, there are numerous provincial programs that provide a broad range of data and analysis that is useful to land use planners; however, there is no single agency responsible for the coordination and dissemination of environmental interpretive mapping. There is therefore a need for:

1. A cooperative and coordinated effort by provincial agencies in the preparation of environmental interpretive mapping for the purposes of assisting land use planners, subdivision approval officers and other users in making settlement land use decisions.

2. Increased provincial resources for the purposes of preparing interpretive mapping on a regional, subregional and local level.

3. Development and dissemination of a suitable methodology/reference manual for the preparation of ecological interpretations that can be used by regional district and municipal professional staff and/or their consultants in the absence of direct provincial support.

4. Priorization of geographic areas for study based on the assessment level of development activity and consequent settlement impacts.

5. Increased comprehensive reconnaissance level or site specific interpretive mapping identifying the following in order of priority:

   a) natural hazards,

   b) terrain suitability for settlement,

c) land and water resources areas sensitive to development.

6. Comprehensive interpretive mapping that would satisfy the principal users responsible for the preparation of official settlement and community plans.

7. Increased dialogue between users and resources scientists to determine interpretive needs.

ACKNOWLEDGEMENTS

I would like to extend my appreciation to Messrs. G. Paget, G.C. Harkness and M.E. Walmsley and to Dr. A.N. Boydell who reviewed and commented on the paper. A special thanks is directed to Mrs. E.G. Holmes for typing of the paper and Mr. G. Blaney for graphics.

REFERENCES

Ministry of Municipal Affairs and Housing. 1977. Municipal Amendment Act. Victoria, B.C.

Ministry of Municipal Affairs and Housing. 1978. 1978(a). Technical Guide for the Preparation of Official Settlement Plans. Planning Services Division. Draft Report.

__________ 1978(b). Technical Guide for the Preparation of Official Community Plans. Planning Services Branch. Draft Report.

Ministry of the Environment. 1977(a). Outdoor Recreation Resources of the Northeast Coal Study Area. Resources Analysis Branch. Victoria, B.C.

__________1977(b). A Preliminary Report on Vegetation of the Tumbler Ridge Townsite. Resource Analysis Branch. Victoria, B.C.

__________1977(c). Aquaric Inventory and Analysis in the Vicinity of the Proposed Tumbler Ridge Townsite. Resource Analysis Branch. Victoria, B.C.

__________1977(d). Preliminary Report on Climate Data for the Tumbler Ridge Townsite Area. Resource Analysis Branch. Victoria, B.C.

__________1977(e). Terrain Analysis for Urban Suitability — Tumbler Ridge. Resource Analysis Branch. Victoria, B.C. Draft Report.

__________1977(f). Wildlife Concerns — Tumbler Ridge Townsite. Resource Analysis Branch. Victoria, B.C. Memo.

Townsite/Community Development Subcommittee. 1977(a) Preliminary Feasibility Report on Townsite/Community Development. Ministry of Municipal Affairs and Housing. Victoria, B.C.

________1977(b).Geotechnical Investigation of Tumbler Ridge Townsite Project.

________1977(c). Conceptual Design — Central Sewerage and Water Supply Works, Tumbler Ridge Townsite.

________1977(d). Groundwater Supply Study, Tumbler Ridge, B.C.

________1977(e). Conceptual Plan, Tumbler Ridge Northeast Sector, B.C.

Transportation Subcommittee, Ministry of Energy, Transport and Communications. 1977. Northeast Coal Access Section 3 — Gwilliam Lake to Tumbler Ridge Highway Routes. Victoria, B.C.

Walmsley, M.E. 1976. Terrain Analysis for Urban Suitability: A Comparison of Alternative Townsite Locations Using Earth Science Information. *in* Proc. Workshop on Ecol. Land Classif. in Urban Areas. pp. 111-132. (comp. and ed. by E.B. Wiken and G.R. Ironside). Lands Directorate, Environment Canada, Ottawa. Ecol. Land Classif. Series No. 3.

ABSTRACT

The application of biophysical mapping for urban settlement planning in light of new provincial legislation is outlined for British Columbia. Mapping prepared for recreational, residential and general urban development at the Tumbler Ridge townsite near Dawson Creek is used as an example. (Ed. Abstr.)

RÉSUMÉ

L'emploi de cartes biophysiques pour planifier les lotissements urbains en Colombie-Britannique est présenté dans ses grandes lignes en tenant compte de la nouvelle législation provinciale. Les cartes dressées pour le développement récréatif, résidentiel et urbain en général de Tumbler Ridge, près de Dawson Creek, sont données comme exemples. (Rés. Éd.)

USER ORIENTED INTERPRETATIONS OF SOIL SURVEYS IN YUKON AND NORTHWEST TERRITORIES

H. P. W. Rostad, L. M. Kozak, and
D. F. Acton
Saskatchewan Institute of Pedology
University of Saskatchewan
Saskatoon, Saskatchewan.

ABSTRACT

In the past few years, several reconnaissance soil surveys were carried out in selected areas of the Yukon and Northwest Territories. The need for these surveys was exemplified in the many requests received by the Federal Lands Office for agricultural leases in the Territories and the lack of information available about the suitability of this land for agricultural or any other use. This lack of information brought about a suspension to the disposition of Federal Crown Land until a land use policy could be developed.

These soil surveys were designed to provide an optimum amount of information regarding the agricultural potential of the areas. A total of 1.2 million hectares of land was surveyed in the Liard River area of the Northwest Territories and another 1.6 million hectares in various portions of the Yukon.

The information gathered during the course of these surveys not only provided a substantial amount of information regarding the agricultural potential of the areas but also provided sufficient information to make several other interpretations. In addition to the basic soil survey map, four interpretive maps were prepared for the Liard River area and 11 interpretive maps were prepared for each of the areas in the Yukon resulting in a total of 137 interpretive maps.

RÉSUMÉ

Depuis quelques années, plusieurs études de reconnaissance ont porté sur les sols de régions du Yukon et des Territoires du Nord-Ouest. Le nombre de demandes reçues par le gouvernement en vue de la location de terres dans les territoires à des fins d'exploitation agricole, et le peu de connaissances sur ces terres (pour l'exploitation agricole ou autre) justifient ces études. A cause du manque d'information, il a fallu arrêter la cession de terres de la Couronne, jusqu'à ce que soit élaborée une politique de l'utilisation des terres.

Les études pédologiques devaient fournir le maximum de données sur les possibilités d'exploitation agricole des régions visées, soit 1.2 million d'hectares dans la région de la rivière Liard (T.N.-O.) et 1.6 million d'hectares au Yukon.

L'information recueillie grâce aux études a permis d'analyser les possibilités d'exploitation agricole de ces régions, et a donné lieu à plusieurs autres interprétations. En plus de la carte pédologique, on a réalisé quatre cartes spécialisées pour la région de la rivière Liard et onze cartes pour chacune des régions étudiées au Yukon, pour un total de 137 cartes spécialisées.

INTRODUCTION

In the past few years the Land Resource Research Institute of the Research Branch, Canada Agriculture, has been involved in several reconnaissance soil surveys in selected areas of the Yukon and Northwest Territories. The request for these surveys originated with the Land Management Section of the Department of Indian and Northern Affairs in direct response to a policy announcement by the Minister of Indian and Norther Affairs. On 10 January, 1975, an announcement by Northern Affiars Minister J. Buchanan stated that the federal government had temporarily suspended the disposition of federal crown lands for agricultural uses in the Territories. He further stated that the suspension was necessary to allow the department time to develop long-term policies for agriculture in the north and so

avoid granting agricultural leases on land which is not suited for that purpose. It was expected the new long-term policy would take two to three years to complete and introduce because of the extensive soil and climatological surveys needed to identify the areas offering the best production potential. (As reported in *News of the North*, Hay River, N.W.T.).

The Federal Lands Offices in Whitehorse and Yellowknife had been receiving applications for agricultural leases on land in widely scattered parts of the Territories. In the Yukon Territory, for instance, the location of many of these lease applications was outside previously surveyed areas. It became evident that these leases could eventually spread onto land that was not suited for agriculture. There was definitely a need for further basic soil survey information and an agricultural assessment of the land and climate in these areas before further leases could be granted. It was felt that a complete land use policy should be developed to control agricultural expansion and recreational development.

Once the decision was made to suspend disposition of federal crown lands, several survey programs were initiated. Due to earlier interest in the north, some soils information was already available for certain areas in the Yukon (Day, 1962) and N.W.T. (Day, 1968). Additional soil surveys were undertaken to extend this knowledge into other areas that might have potential for agricultural development. These soil surveys were carried out by the Land Resource Research Institute, Ottawa, and the Saskatchewan Institute of Pedology, University of Saskatchewan. At the same time, a climatological survey of the Yukon and Northwest Territories was conducted by the Atmospheric Environment Service (Findlay, 1976).

METHODS

In the summer of 1975 a survey of approximately 1.2 million hectares was carried out in the Liard River area of the N.W.T. (Figure 1). The report and interpretive maps were completed the following winter.

In 1976, the Saskatchewan Institute of Pedology carried out a survey of ten selected areas in

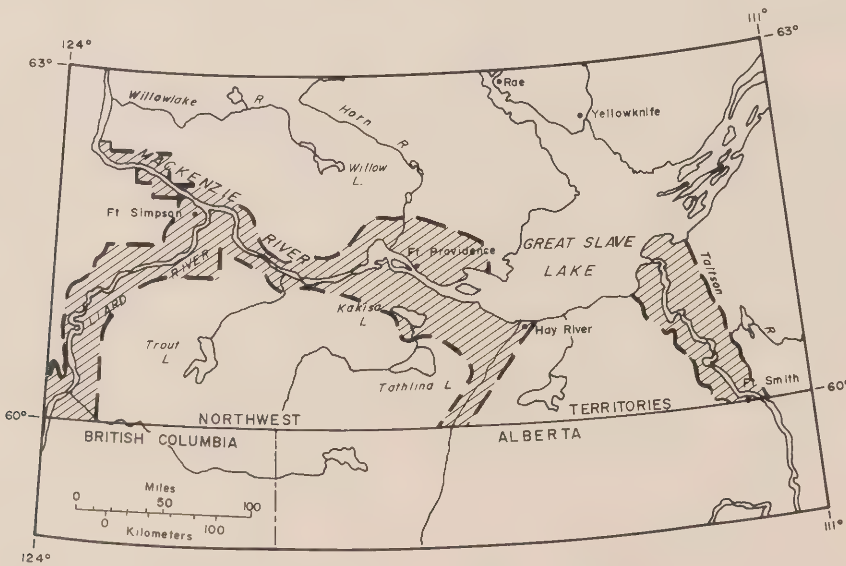
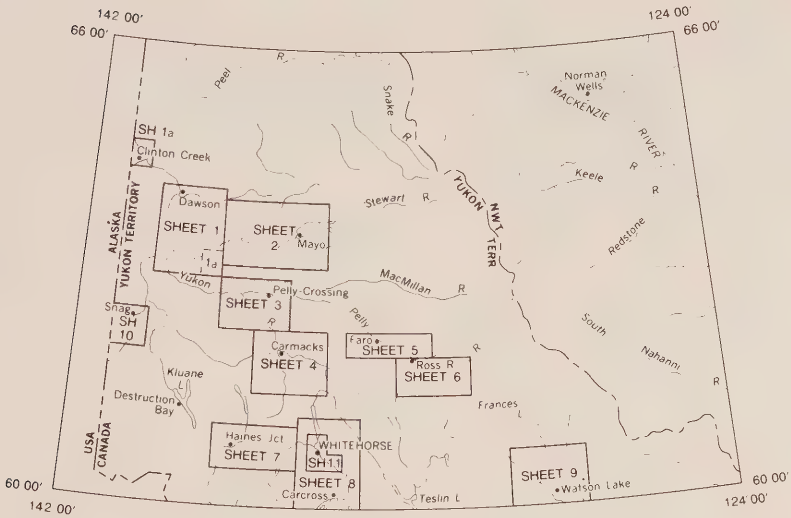


Figure 1: Index map of the southern portion of the Northwest Territories indicating areas studied. The portion along the Liard River was surveyed in 1975.

Figure 2: Map of the Yukon Territory showing the location of all surveyed areas.



the Yukon consisting of approximately 1.6 million hectares (Figure 2).

As with the previous survey the interpretive maps and report were completed in the following winter. In addition, a generalized agricultural capability map and report was prepared for several regions in the N.W.T. (Figure 1).

The field crew for these surveys consisted of three pedologists, an ecologist, and four student assistants. A forage ecologist was also utilized on a temporary basis to assist with the native grazing capability ratings. Wherever possible, trucks and four wheel drive vehicles were utilized. In some of the more remote areas the survey teams had to walk down cutlines, but in other similar areas several spot checks with a helicopter were adequate.

The majority of the costs for these surveys and subsequent interpretations were borne by the Department of Indian and Northern Affairs.

The System of Classification

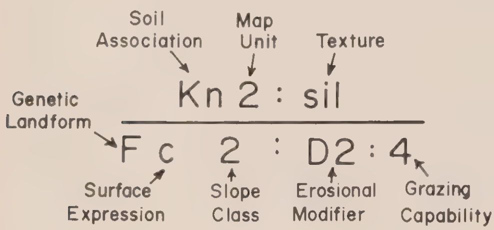
The classification system used throughout the Yukon and N.W.T., was based on *The Canadian System of Soil Classification*. The actual soil separations made in the field and later transferred to the soil maps were based on the concept of the 'soil association'. The soil association is defined as a group of soils developed on similar parent material under similar climatic or physiographic conditions. Since there was very little lead time prior to the actual soil surveys, the legend and mapping units had to be developed as the field work progressed. In most cases, each designated mapping area appeared to be characterized by a relatively unique climate and vegetation. Therefore, in the Yukon survey for instance, new soil association names were used for each major survey area - sheet 1 and 2, sheet 3 and 4, sheet 5 and 6, etc. (Figure 2).

The soil profiles occurring throughout southern Yukon are very similar taxonomically, but the vegetation varies considerably. For example, the midslope position of a loam textured morainal material near Dawson usually represents a well drained Brunisol with aspen and black spruce vegetation, while east of Ross River the same material and slope position results in an imperfectly drained Brunisol with a predominance of black spruce. The same slope position on morainal material near Whitehorse will be a well drained Brunisol, but the dominant

vegetation in this case is usually lodgepole pine. Although each of these three soils are taxonomically similar and occur on the same parent material they constitute different soil associations because of climatic and physiographic differences.

Mapping Units

The boundaries of most of the map units are based on the similarities or differences in the nature of the landform and surficial deposits occurring in an area. These map units are delineated on black and white aerial photographs produced at a scale of 1:40,000. The mapping unit contains the following information:



The legend contains a brief description of each soil association and map unit in regards to taxonomic classification, drainage, and parent material. The description of the dominant vegetation associated with each subgroup of an association are included in the report rather than in the legend. The grazing capability is included in the map symbol because this specific information is unique to each area and cannot be interpreted from any of the other soils information.

INTERPRETATIONS

The Department of Indian and Northern Affairs requested that these soil survey programs be carried out so that they would provide sufficient data to make agricultural interpretations. The department was most interested in knowing which soils had a potential for agriculture and what type of agricultural endeavor would be most feasible on the different soils.

Liard River Survey

A series of interpretive maps at a scale of 1:125,000 were prepared for the Liard River area.

Capability for Agriculture - This classification groups the soils according to their capability for agriculture. The classes and subclasses used are similar to the Canada Land Inventory (CLI) ratings.

Forest Cover - The forest cover map is primarily a summary of existing data from previous surveys carried out by consulting companies and the Forest Management Institute. Areas that had not been surveyed previously were evaluated by air photo interpretation and by reference to data obtained by the soil surveyors. The forest cover was classified according to height class, cover type, and canopy density.

Soil Materials and Drainage - The soils are grouped according to their particle size class, the origin of the soil material, and the slope class. The units also indicated whether the dominant soils are well or poorly drained.

Relative Suitability for Farming Operations - This classification is an attempt at utilizing factors other than soil and climate to determine suitability for agriculture. There are seven suitability classes. Class 1 land has the fewest number of limitations while Class 7 land is not suitable for agriculture. Several of the limitations considered in this classification include agricultural capability, distance from roads, present forest cover, recreational potential, and utilization for wildlife. For example, some of the fertile alluvial soils which have a high capability for agriculture are downrated because they are a favored moose wintering area.

All of these maps were produced at the same scale (1:125,000) on clear plastic suitable for overlaying. The lines and symbols on each map were reproduced in a different color.

Yukon Survey

The Canadian Soil Information System (CanSIS), developed and operated by the Land Resources Research Institute (LRRI) in Ottawa, was used to produce interpretive maps. Basic soil data (mapping units) and soil boundaries were input into the computer. The computer generated a list of all mapping units and the areal extent of each unique unit. The capability now existed for the computer to group the mapping units according to any derived classification system and generate a map showing only the new classification units. In additon, a listing of the areal extent of each of the new classification units could be prepared by the computer.

For the Yukon survey, interpretive maps were

prepared showing the following: 1) Soil Capability for Agriculture, 2) Grazing Capability, 3) Crop Suitability, 4) Suitability for Irrigation, 5) Suitability as a Source of Topsoil, 6) Suitability as a Source of Sand or Gravel, 7) Suitability for Area Type Landfills, 8) Surface Texture, 9) Subsoil Texture, 10) Soil Drainage and Permafrost, and 11) Surficial Material and Topography.

The Soil Capability for Agriculture rating classifies the soils according to their limitations for agriculture, while the Grazing Capability rating utilizes classes based on the annual production of palatable forage. The other suitability ratings use a simple classification system with excellent, fair, and poor classes together with descriptive subclasses describing the main limitations for a particular use.

The computer generated maps are drawn by a plotter on a matte type plastic. Base information can be added to the maps by photo-mechanical techniques. Feedback from the users of the Liard River area maps indicated that the clear plastic overlays were not satisfactory for portraying map information. Through consultation between the users and the cartographers a satisfactory method of visual enhancement was formulated. All maps were superimposed on a clear plastic base and various types of screening and shading were applied to provide a visual contrast between classes (Figure 3).

In addition to the computer drawn maps, generalized Capability for Agriculture maps and Grazing Capability maps at a scale of 1:600,000 were prepared for the report. These maps used screening and color to highlight the classes.

ANTICIPATED USES

Ideally a biophysical classification can serve as a basis for land use planning and policy formulation. However, not all users have the expertise or patience to interpret complex

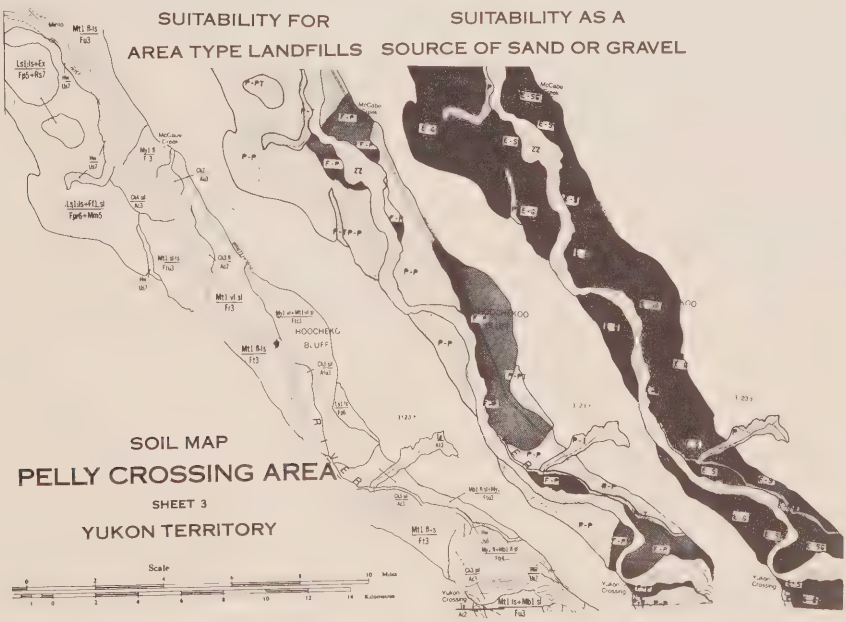


Figure 3: A small portion of the soil map and two interpretive maps near Minto, Yukon Territory.

mapping units for various uses. In many cases, the planners may want to rapidly scan a number of maps to determine regional trends before concentrating on local situations. The project just completed by the Saskatchewan Institute of Pedology is an attempt at fulfilling these requirements.

The report for the Yukon survey is concerned primarily with interpretations and recommendations concerning agriculture. The generalized capability maps form part of the report and attempt to give a general overview of the agricultural potential. The technical data such as soil classification, description of soils, description of vegetation, and acreages for the various interpretations are included in its appendices. For more detailed planning the user can utilize the single and multiple factor interpretive maps that are published at a scale of 1:125,000. Finally the original soils map is available if the user intends to make other interpretations or check on the present interpretations.

COSTS

The following cost estimates were prepared for the period April 1975 to September 1977 and include the following maps and reports:

1. Soil Survey and Land Evaluation of the Liard and Mackenzie River area (300 page report).

2. Clear plastic overlay maps at 1:125,000 for 1.2 million hectares. (This includes a soils map and four interpretive maps for the Liard and Mackenzie River Area).

3. Soil Survey and Land Evaluation of the Yukon Territory (500 page report).

4. A soil map and 11 interpretive maps covering 1.6 million hectares. (This includes 12 maps for each of the ten different areas in the Yukon).

5. Fifteen generalized color maps at a scale of 1:600,000 (Yukon).

6. Soil Survey and Land Evaluation of the Hay River Area (100 page report).

7. A soil map and 11 interpretive maps for 300,000 hectares at a scale of 1:125,000 (Hay River Area).

8. Agricultural Potential of selected areas in the N.W.T. (60 page report - an overview of previously surveyed areas in the N.W.T.).

9. Four generalized capability maps at a scale of 1:500,000 (N.W.T.).

10. Soil map and 11 interpretive maps for eight urban areas in the Yukon at a scale of 1:15,000.

The total expenses incurred can be broken down into two categories.
1) the field and office expenses incurred by the Saskatchewan Institute of Pedology, and
2) the cartographic and computer expenses incurred by the LRRI in Ottawa.

The field and office expenses including salaries for the 2.5 year period were approximately \$324,000 or \$10.00/km^2 surveyed. The cartographic costs of labor and materials were about \$80,000 or \$2.47/km^2 This cost estimate does not include overhead and computer time. Altogether these survey projects covered 15 map sheets with an average size of 200,000 hectares and resulted in a total of 137 interpretive maps.

REFERENCES

Day, J.H. 1962. Reconnaissance soil survey of the Takhini and Dezadeash Valleys in the Yukon Territory. Research Branch, Agriculture Canada, Ottawa. 78 p. and map.

Day, J.H. 1968. Soils of the Upper Mackenzie River area, Northwest Territories. Agriculture Canada, Ottawa.

Findlay, B.F. 1976. Recent developments in ecoclimatic classifications. *in* Proc. 1st Meeting Can. Comm. Ecol. Land Classif. (comp. and ed. by J. Thie and G. Ironside). Ecol. Land Classif. Series No. 1. Lands Directorate, Environment Canada, Ottawa. pp. 121-127.

INTERPRETATION OF AN ECOLOGICAL DATA BASE USING THE CANADA LAND DATA SYSTEM

J. Thie and N. Chartrand
Lands Directorate
Environment Canada
Ottawa, Ontario

G. F. Mills
Canada-Manitoba Soil Survey
University of Manitoba
Winnipeg, Manitoba

ABSTRACT

An integrated ecological land data base provides a great flexibility in interpretations to resource planners and managers. The wide variety of questions that can be asked of and answered instantaneously by such a data base is demonstrated through interactive analysis capabilities of the Canada Land Data System (CLDS). For this purpose the CLDS was adapted to store and analyse ecological data for an area of about 1800 km^2 mapped by the Manitoba Northern Resource Information Program. This paper was originally written as background material for an Interactive Graphics Display demonstration given at a CCELC workshop in Victoria.

RÉSUMÉ

Une base intégrée de données écologiques sur les terres permet beaucoup de latitude d'interprétation aux planificateurs et aux gestionnaires des ressources. L'éventail des questions qu'on peut poser et auxquelles on peut obtenir une réponse immédiate grâce à pareille base est mis en évidence par le potentiel d'analyse interactive du Système de données sur les terres du Canada. Ce système a été adopté pour accumuler et analyser des données écologiques visant une superficie de terrain d'environ 1800 km^2 qui a été cartographiée dans le cadre du programme manitobain d'information sur les ressources du Nord. Le présent document fournit les assises d'une démonstration d'affichage graphique interactif qui a eu lieu à l'occasion d'un atelier tenu par le CCCET à Victoria.

INTRODUCTION

In the past, most inventories and surveys were carried out to answer specific resource management questions. The single-disciplinary approach evolved into a multidisciplinary one when it became apparent that multiple land resource demands existed and that land use conflicts were common.

The Canada Land Inventory (CLI) project reflects the public perception, in the fifties and sixties, of what type of resource management was required to solve some of Canada's land use problems. This multidisciplinary survey provides land capability information for Forestry, Agriculture, Wildlife (waterfowl and ungulates), Sportfish, Recreation, and Present Land Use information.

In practice, however, multidisciplinary surveys such as the CLI answered only a limited number of the questions which planners ask of a data base. The use of this data base is restricted for two reasons:

(1) The inventory describes the resource potential for only a limited number of disciplines.

(2) The original ecological data, which formed the basis for the land capability rating, usually was not reported on and is therefore essentially not available for 'extra' analysis.

A third problem results from the fact that non-integrated single-and multi-disciplinary surveys create units for management and planning which, at the same scale, may show similarities, but are never identical. Overlaying maps, as part of a planning exercise, generates many boundary units with little or no significant meaning (Figure 1).

Ecological (biophysical) land classification methodology was originally developed to form the basis for an extension of the CLI in northern areas. Coverage of large inaccessible areas was contemplated in a relatively short period of time. Classification and operational approaches would have to allow the creation of a

Figure 1: A multiple overlay of 1:50,000 scale CLI maps (reduced in this figure) showing forestry, agriculture, waterfowl, recreation, present land use and administrative boundaries.

data base for resource management at a reasonable cost. Considering the experience with the CLI data and reflecting the new perception offered by integrated, environmental resources management, it is not surprising that an ecologically-based integrated survey approach evolved. Though the extension of the CLI did not materialize, ecological (biophysical) land surveys have been carried out in many parts of Canada by a wide range of agencies (CCELC, 1977). Initially, primarliy CLI-type interpretations have been attempted. However, due to the integrated ecological basis, the data lends itself to a far wider range of interpretations as well demonstrated by Jurdant et al (1977).

To demonstrate the flexibility of interpretation of an ELC data base to potential users, a pilot study was carried out by the Lands Directorate (Environment Canada) and the Manitoba Northern Resource Information Team. This study was also intended to demonstrate the effectiveness of the computer storage and retrieval of ELC information. One 1:125,000 - scale biophysical map (Figure 2) was stored in the Canada Land Data System. The complex geomorphology legend (Figure 5) and soil and vegetation legends (Figure 3) are stored in such a way that each parameter can be retrieved and mapped separately or in combinations with one or more other parameters.

NORTHERN RESOURCE INFORMATION PROGRAM IN MANITOBA

A systematic biophysical land classification of Northern Manitoba was initiated in July 1974. A detailed description of this program is given

by Mills (1976). To-date, over 100,000 km^2 has been covered and maps and reports are in various stages of production. The purpose of the Northern Resource Information Program is to provide basic data for resource use planners. This means generally the provision of data useful for macro-scale planning, although the data may be in some instances sufficient for limited micro-scale planning. Because of the reconnaissance nature of the program, the usefulness of the data will be greatest when applied at a broad regional level. This means that the data will be useful for the planning for the development of renewable and non-renewable resources on a regional basis — for planning for industrial and community development, the protection of the environment, the development of infrastructure, etc.

The system of classification used by the NRIP is closely patterned after that of the Sub-committee on Biophysical Land Classification (Lacate, 1969).

Data Presentation

Although the basic document of the biophysical land classification in Manitoba is a map and legend depicting land systems at a scale of 1:125,000, the relationship between patterns of Land Types and Land Systems is always considered in the context of Land Regions and Districts. Region and District boundaries are superimposed on the Land System map, and a description of their biophysical condition is included in narrative form in an accompanying text.

The boundaries of most map units are based initially on landform and related surface deposits and are delineated on panchromatic, black-and-white, 1:60,000-scale aerial photographs. The landform units are usually further refined in terms of topographic variation and patterns of soils, drainage condition, and vegetation. Such characterization of the landform units is accomplished through the field program involving detailed descriptions of the soil, vegetation, and topographic conditions on selected portions of a landform. These site descriptions generally apply to a landscape segment equivalent to a Land Type or a complex of Land Types.

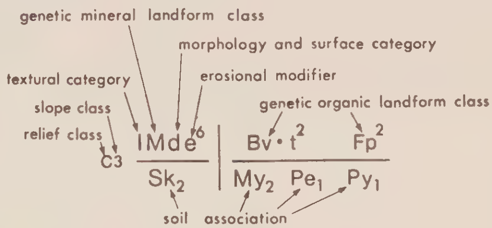
Land Systems depicted at the 1:125,000 scale are characterized by a recurring pattern of landforms, soils, and vegetation. The unit is described by a map symbol providing the user with a fair account of the land characteristics; for more detailed information, however, the user must consult an extended legend.

The map symbol for a Land System is set up in the following manner:

topographic expression	Mineral landforms / Soil Association(s)	Organic landforms / Soil Association(s)

The various components of the landscape in a particular Land System are described in terms of genetic landform, textural category of the surficial deposits, the kind of morphology and surface form, erosional modifier, slope and relief class, and soil association.

Map Symbol:



The soil association symbol directs the user to the expanded legend (Figure 4) which will provide information about the Land Region, parent material, the various soil subgroups belonging to the association, drainage, landscape position of the dominant member of the association, ice content and depth of thaw of permafrost, and the vegetation associated with the dominant soil subgroup.

CANADA LAND DATA SYSTEM (CLDS/CGIS) GRAPHICS SUBSYSTEM

The Canada Land Data System/CGIS was originally designed to handle all Canada Land Inventory data, which covers about 2.5 million km^2 of Canada's land mass. The storage of this massive data base was the first priority for the CLDS. At present, 98% of the CLI data is stored in the CLDS. The system is now expanding its services to a wider range of users and is storing a diversity of information. The CLDS was adapted to handle complex ecological data, to allow further expansion of the national data base to northern areas not covered by the CLI.

This demonstration makes use of the CLDS Graphics Subsystem, which allows the user to interact with the data base instantaneously. This system was modified to handle the large range of parameters associated with each of the NRIP map polygons.

The organization (i.e. map symbols and

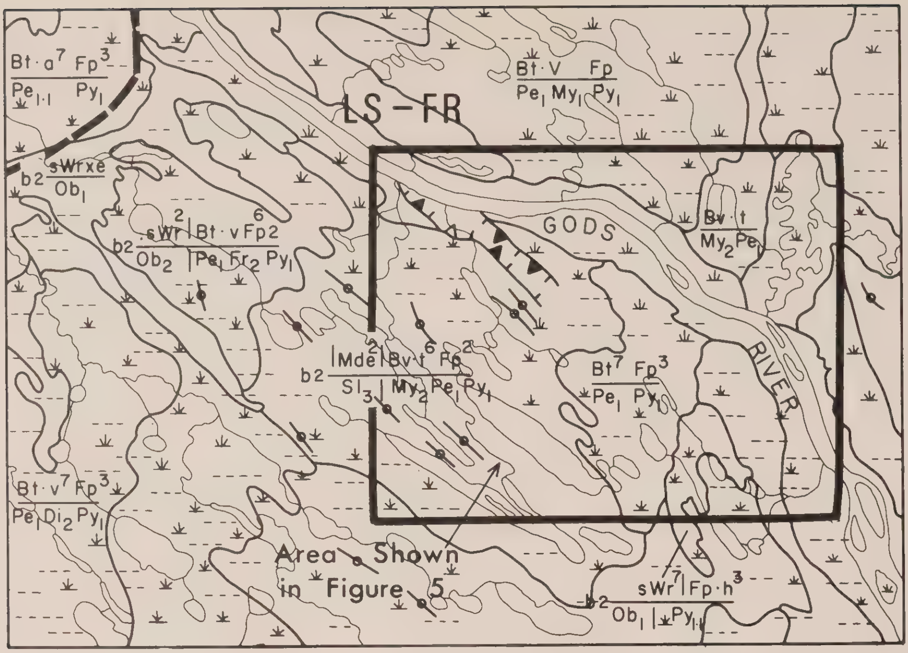


Figure 2: Portion of 1:125,000 scale biophysical map of the Hayes River area

Figure 3: Geomorphology Legend

GENETIC MINERAL LANDFORM CLASS

A alluvial
C colluvial
E eolian
G glacio-fluvial
L glacio-lacustrine
M morainal
W marine
U undifferentiated

BEDROCK CLASS

aR bedrock, acidic
bR bedrock, basic
cR bedrock, carbonatic
uR bedrock, undifferentiated

MORPHOLOGY AND SURFACE FORM CATEGORY

(placed after landform class)

p plain
h hummocky
u undulating
m rolling
d drumlinized
k kettled
r ridged
t terraced
a apron
Δ delta
f fan
b blanket
v veneer

TEXTURAL CATEGORY (placed before landform class)

c clayey
l loamy
s sandy
f fragmental (gravelly, cobbly or bouldery)
-s skeletal (used in combination with clayey, loamy or sandy)

EROSIONAL MODIFIER (placed after morphology & surface form category)

c channeled
e eroded
i dissected
l deflated
w washed

GENETIC ORGANIC LANDFORM CLASS AND CATEGORY

B Bog

a palsa
b bowl bog
f flat bog
l blanket bog
m peat mound
p bog plateau
t peat plateau
v bog veneer
y polygonal peat plateau

F Fen

c collapse scar
f floating fen
h horizontal fen
l sloping fen
m minerotrophic palsa
p patterned fen

S Swamp

RELIEF CLASS (meters)		SLOPE CLASS degrees	%
a 0- 2	1	0- 2	0- 5
b 3- 5	2	3- 7.5	6-15
c 6-20	3	8-15	16-30
d 21-50	4	16-30	31-60
e 51-100	5	>30	>60
f >100	6	complex	

BIO-PHYSICAL BOUNDARIES

Land Region → LS-FR
Land District
Land System

NOTES:
1. See text for explanation of Map Symbol
2. See Table 1 for soil and vegetation
3. See Appendix III for definition of terms

Figure 4: Portion of the extended legend, Hayes River Map area, 54C Manitoba

LEGEND FOR SOIL AND VEGETATION

Soil Association		Land Region	Parent Material	Map Unit Symbol	Soil and Drainage[4]		Landscape Position[3]	Ice Content and Depth of Thaw[3]	Dominant Vegetation[3,5]
Symbol	Name				Dominant Subgroup[1]	Significant Subgroup Inclusions[2]			
Di	Deer Island	LS	Shallow (40-160 cm) deposits of mesic to humic forest peat with alternating subdominant layers of fibric sphagnum peat and/or mesic fen peat underlain by medium to fine textured marine sediments.	Di_1	Terric Mesic Organo Cryosol (i-p)		Raised peat plateaus and palsas	High; 50 cm	bS-Er-Li-Fm bS-Er-Sp-Fm
				Di_2	Terric Mesisol (p)	Terric Mesic Organo Cryosol (p-i)	Gently sloping areas with shallow channels, runnels and depressions	Moderate; 50 cm to 100+ cm	bS-Sp-Er bS-Fm-Er-Li
Pe	Pemichagamau	LS	Deep (>160 cm) deposits of mesic to humic forest peat	Pe_1	Mesic Organo Cryosol (i-p)	Typic Mesisol	Raised peat plateaus and palsas	High; 50 cm	bS-Er-Li-Fm bS-Er-Sp
Py	Pennycutaway	LS	Deep (>160 cm) deposits of mesic fen peat or very thin (15-60 cm) discontinuous fibric sphagnum peat overlying fen peat.	Py_1	Typic Mesisol (v)	Typic Mesisol, sphagnic phase (v)	Level to depressional fens, water track fens	Non-frozen	Cx-Dp-Co
				Py_2	Typic Mesisol, sphagnic phase (v)	Typic Mesisol (v)	Level to depressional fens	Non-frozen	tL-Cx-Dp-Sp
Sl	Strobus Lake	LS	Very strongly calcareous, medium to moderately fine textured stony till.	Sl_1	Degraded Eutric Brunisol (w)	Orthic Grey Luvisol (w) Gleyed Degraded Eutric Brunisol (i)	Apex and upper slopes	Non-frozen	bS-(jP-tA)-Fm-Al
				Sl_2	Gleyed Degraded Eutric Brunisol (i)	Rego Gleysol, peaty phase (p) Gleysolic Static Cryosol, peaty ph.(p)	Mid to lower slope	None to moderate; 50 cm to 100+ cm	bS-Fm-Er-Al
				Sl_3	Rego Gleysol, peaty phase (p)	Gleysolic Static Cryosol, peaty ph.(p)	Depressional to level	None to high; 50 cm to 100+ cm	bS-Sp-Er-Fm

Notes:
1. Dominant subgroup comprises more than 40 percent of soil association.
2. Significant subgroup inclusions are 20 to 40 percent of soil association. Minor subgroups are listed in order of dominance.
3. Landscape position, ice content, depth of thaw and dominant vegetation refer to the dominant subgroup.
4. Drainage classification
   - e - excessively drained
   - w - well drained
   - i - imperfectly drained
   - p - poorly drained
   - v - very poorly drained
5. Vegetation: species abbreviation
   - Dp - Drepanocladus
   - bS - black spruce (*Picea mariana*)
   - wS - white spruce (*Picea glauca*)
   - wB - white birch (*Betula papyrifera*)
   - Bi - dwarf birch (*Betula glandulosa*)
   - tL - tamarack (*Larix laricina*)
   - Wi - willow (*Salix* sp.)
   - Al - alder (*Alnus* sp.)
   - tA - trembling aspen (*Populus tremuloides*)
   - bPo - black poplar (*Populus balsamifera*)
   - Cx - Sedge (*Carex* sp.)
   - Co - Cottongrass (*Eriophorum* sp.)
   - Li - Lichen (*Cladonia* sp.)
   - Sp - Sphagnum (*Sphagnum* sp.)
   - Er - Ericareae (*Ledum*, *Chamaedaphne*, *Kalmia*, etc.)
   - Fm - Feathermosses
   - jP - Jack Pine (*Pinus banksiana*)

extended legend) of the NRIP data was not designed with computer data handling in mind, and this complicated the procedures for handling and retrieving. Each map polygon or point of information in the biophysical data base is characterized by environmental parameters in the map symbol as well as by the extended legend. Approximated climatic information (Ecoregions) and land information are stored in map symbols while vegetation information is stored in the extended legend. To handle this data, CLDS staff developed a software package that allows the characterization of each map polygon by a series of 15 variables. Each of the variables may have a maximum of 50 values. This means that a maximum of 750 environmental parameters can be handled for each polygon. The following variables are used in this demonstration:

- SHORELINE
- REGION
- DISTRICT
- RELIEF
- SLOPE
- TEXTURAL CATEGORY OR ORGANIC LANDFORM
- GENETIC MINERAL CLASS
- MORPHOLOGY & SURFACE FORM
- EROSIONAL MODIFIER
- MINERAL & ORGANIC PERCENTAGES
- DRAINAGE
- SOIL CLASS
- PERMAFROST
- VEGETATION

The values, in this case, are descriptions given in the legend (Figure 3 and Figure 4). For example, the genetic mineral landform class (GENCL) is described by A (alluvial), C (colluvial), etc. Permafrost is described by ice content and occurrence - H (high), M (moderate), and NF (non-frozen). Each value can be retrieved separately or in combinations with any other(s). The retrieved information is displayed as:

1. A summary report depicting, by variable value(s), the area of land which satisfies the selection criteria;

2. A map of the study area showing the polygons with the selected criteria.

The CLDS Graphics Subsystem is simple. A user, without previous experience can learn to retrieve data within a half hour. After logging onto the system, the following commands can be entered:

<u>LIST</u> lists the variables available in the data base.

<u>SELECT</u> selects polygons by classification (by variable and value specification) and produces a summary report.

<u>RESELECT</u> selects polygons by classification using different values for the variables processed in the last selection, and produces a Summary Report.

<u>PLOT</u> plots polygons selected by the last selection.

<u>SAVEC</u> saves the origin and scale of the last plot blow-up (minimum and maximum X and Y coordinates of the blow-up) so that plots of subsequent selections and/or reselections will be confined to that portion of the study area delimited by the SAVEC command.

<u>DELETEC</u> restores the original scale for plotting the entire study area (i.e. it cancels the effects of the SAVEC command).

<u>SCALE</u> permits the specification of the scale desired on the paper copy of a screen image produced by the hard copy copy unit connected to the Tektronix CRT (Cathode Ray Tube).

<u>NOSCALE</u> restores the scale to that of either the original data base or the scale of the last map plotted, if in plot mode.

<u>SUPMSG</u> suppresses some prompting messages.

<u>MSG</u> restores prompting messages suppressed by SUPMSG command.

<u>STRLEN</u> changes the length of line displayed at the terminal.

<u>STOP</u> stops the interactive computer program.

The LIST command provides the list of the variables that can be used for retrieval:

```
ENTER COMMAND
LIST
VARIABLES AVAILABLE IN THIS DATA BASE
SHRLN - SHORELINE                                1    3
REGN  - REGION                                   2    5
DSTR  - DISTRICT                                 2    9
RELF  - RELIEF                                   1    6
SLOPE - SLOPE                                    1    6
TEXOF - TEXTURAL CATEGORY OR ORGANIC LANDFORM    2   21
MINLD - GENETIC MINERAL CLASS                    2    8
MORPH - MORPHOLOGY & SURFACE FORM                2   50
EROSX - EROSIONAL MODIFIER                       2    5
PCNTX - MINERAL & ORGANIC PERCENTAGES            1   10
DRAIN - DRAINAGE                                 2   10
SOILX - SOIL CLASSIFICATION                      4   40
PERMF - PERMAFROST                               3   10
VEGET - VEGETATION                               8   50
SPARE -                                          3    1
MAX NUMBER OF VALUES PER VARIABLE       50
SCALE OF INPUT DATA BASE IS 1 : 125,000
ENTER COMMAND
?
```

Each of the variables, either single or in combination with others, can be used for retrieval. By using single parameters like sand (s) or gravel (f), from the variable TEXOR potential areas with aggregate materials can be identified (Figure 5). The distribution of areas with sensitive surface layers due to permafrost (Figure 6) can be obtained as follows:

1) select input value B (bog) from TEXOR
2) select input value P (permafrost) from PERMF
3) select 6,7,8,9 (more than 60%) from PCNTX.

Values and variables may be combined into land capability maps. For example, per definition, similar forest sites within a Land Region will have similar forest productivity. Field data may have shown that class 5 forest capability will occur on well to moderately well-drained clay and loam materials, in the high boreal Land Region.

By specifying the variables:

Land Region concerned - REGNX
Textural Category - TEXOR
Drainage Condition - DRAIN

and entering for each the corresponding values-HB (High Boreal), C (Clay), L (Loam), W (Well drained), and M (Moderately drained), a map and area statistics can be made which shows the distribution of class 5 forest capability is the study area (Figure 7).

Given the number of variables (15) and values (50), a very large number of retrievals is possible. This gives great flexibility to a planner or manager using ecological land survey information. Ecological Land Surveys and land data systems like the CLDS can improve each others efficiency. The computer allows easy evaluation and mapping of complex and difficult to interpret map symbols and legends. The Ecological Land Survey provides a simpler geographic data base, fewer overlays and reduces computation time.

REFERENCES

CCELC, 1977. Ecological (Biophysical) Land Classification in Canada: Proc. First Meeting Can. Comm. on Ecol. (Biophys.) Land Classif., 25-28 May 1976, Petawawa, Ont. Ed. by J. Thie and G. Ironside. Ecol. Land Classif. Ser. No. 1, Lands Directorate, Environment Canada, Ottawa. 269 p.

Jurdant, M., J.L. Bélair, V. Gerardin, and J.P. Ducruc. 1977. L'inventaire du Capital-Nature: Méthode de classification et de cartographie écologique du territoire. Ecol. Land Classif. Ser. No. 2, Lands Directorate, Envir. Can., Ste. Foy, Quebec. 202 p.

Lacate, D.S. 1969. Guidelines for Biophysical Land Classication. Canadian Forestry Service. Publ. No. 1264. Ottawa. 61 p.

Mills, G.F. 1977. Biophysical Land Classification of Northern Manitoba: Proc. 1st Meeting. Can. Comm. Ecol. Land Classif. pp. 201-219. Ecol. Land Classif. Series, No. 1. Lands Directorate, Environment Canada. Ottawa.

```
                    SUMMARY OF AREAS SELECTED
      SELECTION   3                NOV. 29/78     PAGE    1
VARIABLE : TEXOR
VALUE                    ACRES        HECTARES   %SEL AREA    %STUDY AREA
S                     25,334.9        10,260.6     100.0           1.6

TOTAL SELECTED        25,334.9        10,260.6

TOTAL STUDY AREA   1,573,878.5       637,420.8
ENTER COMMAND

PLOT  3  APPX SCALE - SCREEN 1 :     416,199  PAPER COPY 1 :    618,354
```

Figure 5: Distribution of areas with potential of aggregate materials.

```
                           SUMMARY OF AREAS SELECTED
             SELECTION   9                APR. 02/78     PAGE    1
VARIABLE : TEXOR
VALUE                     ACRES        HECTARES    %SEL AREA    %STUDY AREA
BV                      7,356.2         2,979.2        5.4           0.4
BT                    128,739.7        52,139.5       94.5           7.5
VARIABLE : PCNTX
VALUE                     ACRES        HECTARES    %SEL AREA    %STUDY AREA
6                      50,989.5        20,650.7       37.4           3.0
7                      57,019.9        23,093.0       41.8           3.3
8                      25,935.2        10,503.7       19.0           1.5
                        2,151.2           871.2        1.5           0.1
VARIABLE : PERMF
VALUE                     ACRES        HECTARES    %SEL AREA    %STUDY AREA
PMH                     8,485.3         3,436.5        6.2           0.5
PH                    124,620.6        50,471.3       91.5           7.3
PLM                     2,989.9         1,210.9        2.1           0.1
VARIABLE : VEGET
VALUE                     ACRES        HECTARES    %SEL AREA    %STUDY AREA
BSLGRCLI                4,119.0         1,668.2        3.0           0.2
BSLGLDVC              124,620.6        50,471.3       91.5           7.3
BSLGLDOX                4,366.2         1,768.3        3.2           0.2
BSLGVCOX                2,989.9         1,210.9        2.1           0.1

TOTAL SELECTED        136,095.9        55,118.8

TOTAL STUDY AREA    1,694,593.0       686,310.1
ENTER COMMAND

PLOT  9  APPX SCALE - SCREEN 1 :     416,199  PAPER COPY 1 :     662,964
```

Figure 6: Distribution of areas with permafrost

```
INPUT VALUE(S) TO BE SELECTED FROM : REGNX
HB
HB
INPUT VALUE(S) TO BE SELECTED FROM : TEXOR
C/L
C/L
INPUT VALUE(S) TO BE SELECTED FROM : PCNTX
6/7/8/9/$
6/7/8/9/$
INPUT VALUE(S) TO BE SELECTED FROM : DRAIN
W/M
W/M
ARE THE VARIABLES ABOVE CORRECT AND COMPLETE? ANSWER (YES) OR NO

                         PRESS RETURN FOR SUMMARY REPORT

***                        SUMMARY OF AREAS SELECTED                      ***
***        SELECTION   8               APR. 02/78    PAGE   1            ***
VARIABLE : REGNX
VALUE                       ACRES        HECTARES     %SEL AREA    %STUDY AREA
HB                       54,894.4        22,232.2       100.0           3.2
VARIABLE : TEXOR
VALUE                       ACRES        HECTARES     %SEL AREA    %STUDY AREA
L                        54,894.4        22,232.2       100.0           3.2
VARIABLE : PCNTX
VALUE                       ACRES        HECTARES     %SEL AREA    %STUDY AREA
6                        17,630.3         7,140.2        32.1           1.0
                         13,349.2         5,406.4        24.3           0.7
7                         8,484.3         3,436.1        15.4           0.5
8                        15,430.4         6,249.3        28.1           0.9
VARIABLE : DRAIN
VALUE                       ACRES        HECTARES     %SEL AREA    %STUDY AREA
W                        53,365.3        21,612.9        97.2           3.1
M                         1,529.1           619.2         2.7           0.0

TOTAL SELECTED           54,894.4        22,232.2

TOTAL STUDY AREA      1,694,593.0       686,310.1
ENTER COMMAND
P

PLOT  8  APPX SCALE - SCREEN 1 :    416,199  PAPER COPY 1 :    662,964
```

Figure 7: Distribution of areas with a dominance of class 5 forest productivity.

```
                         SUMMARY OF AREAS SELECTED
        SELECTION   6                              APR. 02/78    PAGE   1
VARIABLE : PCNTX
VALUE                     ACRES        HECTARES    %SEL AREA    %STUDY AREA
                       40,080.9        16,232.7       41.9          2.3
8                      55,510.4        22,481.7       58.0          3.2
VARIABLE : SOILX
VALUE                     ACRES        HECTARES    %SEL AREA    %STUDY AREA
 DEB                   23,297.0         9,435.2       24.3          1.3
TFOC                    2,391.2           968.4        2.5          0.1
  HM                    1,048.9           424.8        1.0          0.0
 OGL                   28,381.5        11,494.5       29.6          1.6
 TMF                    7,544.3         3,055.4        7.8          0.4
GDEB                    2,819.1         1,141.7        2.9          0.1
  TM                      689.7           279.3        0.7          0.0
 GCR                    3,724.1         1,508.2        3.8          0.2
 MOC                   25,695.2        10,406.5       26.8          1.5

TOTAL SELECTED         95,591.3        38,714.4

TOTAL STUDY AREA    1,694,593.0       686,310.1

ES
INPUT VALUE(S) TO BE SELECTED FROM : PCNTX
[illegible]
[illegible]
INPUT VALUE(S) TO BE SELECTED FROM : SOILX
F

***                      SUMMARY OF AREAS SELECTED                                ***
***     SELECTION   7                              APR. 02/78    PAGE   1         ***
VARIABLE : PCNTX
VALUE                     ACRES        HECTARES    %SEL AREA    %STUDY AREA
                       19,722.1         7,987.4       75.5          1.1
8                       6,393.9         2,589.5       24.4          0.3
VARIABLE : SOILX
VALUE                     ACRES        HECTARES    %SEL AREA    %STUDY AREA
 DEB                   23,297.0         9,435.2       89.2          1.3
GDEB                    2,819.1         1,141.7       10.7          0.1

TOTAL SELECTED         26,116.1        10,577.0

TOTAL STUDY AREA    1,694,593.0       686,310.1
ENTER COMMAND
P
PLOT  7  APPX SCALE - SCREEN 1 :   416,199  PAPER COPY 1 :   662,964
```

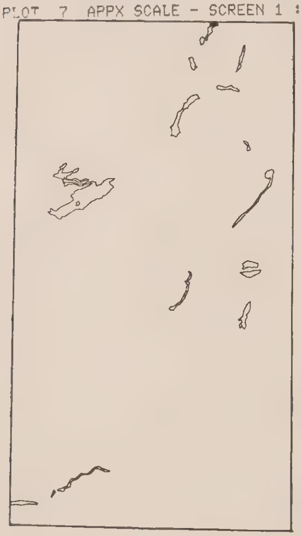


Figure 8: Distribution of brunisolic soils

ECOLOGICAL LAND SURVEY OF THE NORTHERN YUKON

E. B. Wiken, D. M. Welch,
G. Ironside and D. G. Taylor

Lands Directorate
Environment Canada
Ottawa, Ontario

ABSTRACT

An ecological land survey of the northern tip of the Yukon was conducted in the summer of 1977. The study included most of the area north of the Porcupine and Bell rivers and covered approximately 35,100 km^2. The survey is considered exploratory, having averaged only one short field check for roughly every 650 km^2 and having little existing environmental baseline information or benchmark studies.

The land surveyed in this study is perhaps the most ecologically diverse in Canada's north. Land ecosystems range from relatively stable to delicately balanced, each having marked inherent differences in climate, geology, soils, hydrology, flora and fauna. Many of the variations, such as the extensive tracts of unglaciated terrain, the large caribou herd and the oriented lakes, are themselves distinctive natural phenomena in Canada. Most of the study area remains virtually unsettled.

This paper describes the objectives, general environment and aspects of the methodology employed. Three levels of ecological generalization were addressed, including the ecoregions, *the* ecodistricts *and the* ecosections. *For each level treated there is, in addition to the text, maps respectively at the scales of 1:1,000,000, 1:500,000 and 1:250,000. The ecosection generalizations, unlike the other two, are only delineated for the western third of the study area. The interpretations made regarding outstanding phenomena, recent history of man, and wildlife habitat are also discussed.*

RÉSUMÉ

Un relevé écologique des terres de l'extrémité nord du Yukon a été effectué pendant l'été 1977. Il visait la majeure partie de la région du Yukon qui se situe au nord des rivières Porcupine et Bell, soit environ 35 100 km^2. Il s'agissait d'un relevé d'exploration puisqu'on n'a effectué qu'une brève vérification sur le terrain pour chaque 650 km^2, et qu'on ne disposait que de peu de renseignements environnementaux de base ou d'études-repères.

Les terres étudiées au cours de cette reconnaissance sont peut-être les plus variées, du point de vue écologique, du Nord du Canada. Certains écosystèmes sont relativement stables alors que d'autres sont d'un équilibre précaire et subissent des fluctuations climatiques, géomorphologiques, pédologiques, hydrologiques, végétales et fauniques marquées. Maints caractères de ces écosystèmes, tels que les vastes étendues de terrain ayant échappé à la glaciation, l'immense harde de caribou et les lacs orientés, sont d'ailleurs propres au Canada. Une grande partie de la région étudiée est encore en évolution active.

Le rapport de relevé décrit les objectifs et la méthode d'étude ainsi que l'environnement général observé. La généralisation s'est déroulée sur trois niveaux, soit sur les échelles des écorégions, *des* écodistricts *et des* écosections. *Des cartes aux échelles respectives de 1:1 000 000, 1:500 000 et 1:250 000 accompagnent les textes sur ces étapes. Les généralisations à l'échelle des écosections diffèrent des autres du fait qu'elles ne s'appliquent qu'au tiers ouest de la région à l'étude. Le rapport traite aussi des conjectures au sujet des phénomènes exceptionnels, de l'intervention récente de l'homme et des habitats de la faune dans la région concernée.*

INTRODUCTION

The northern Yukon Territory is among the more diverse northern ecosystems in Canada. It contains marked variations in phenomena such as geology, geomorphology, climate, vegetation, wildlife and water. As this area has been relatively untouched by human occupation, the pristine qualities of the land have been maintained. Several of these qualities are of striking distinctiveness and, in some cases, of unique significance. Tangible evidence to this effect is provided by the manifold forms

of interest expressed in this area. For example, the northern Yukon Territory is: an integral segment of the arctic wildlife range for one of the world's last great caribou herds — the Porcupine herd; an important locale for North American archaeological and paleontological studies; an area containing several ecological sites under the International Biological Program as well as several sites for possible inclusion on UNESCO's World Heritage List; a significant hunting and trapping territory for native groups; a major breeding, staging and molting site for waterfowl; and one of the few Canadian landscapes which possesses large tracts of land unmodified by the Quaternary glaciation. In recogintion of these concerns and their national and international significance, Parks Canada requested that the Lands Directorate provide an ecological data base that would allow appropriate management and planning strategies to be formulated.

To acquire the baseline data, an exploratory ecological land survey was conducted during a ten-day period in July and August of 1977. The survey utilized an interdisciplinary team composed of scientists with backgrounds in geology, geomorphology, climatology, pedology, hydrology, botany and biology. During the field operations, the team verified the various forms of land ecosystems which had been delineated on aerial photographs and satellite images. This involved a reconnaissance overflight as well as limited helicopter transverses to furnish supportive ground truthing. The study area, illustrated in Figure 1, encompasses approximately 35,100 km^2 and lies within the 1:250,000 Canadian topographical series 117 A/B/C/D and 116 N/O/P. For area 'B', the biological and physical land characteristics in the context of *Ecoregions* and *Ecodistricts* of the ecological land classification approach are described; for area 'A', however, additional work at the *Ecosection* (land system) level of generalization was also detailed. The maps provided for each level of generalization noted are respectively at the scales of 1:1,000,000, 1:500,000 and 1:250,000. The scope of the report is fairly comprehensive. However, owing to the paucity of field checks and of supplementary information from single disciplinary studies in parts of this study area, the investigation was an exploratory survey.

GENERAL ENVIRONMENTAL SETTING

Biological and physical forces have, over millions of years, been molding the environment of the northern Yukon. Their influence continues, although the duration and magnitude of these forces have been dissimilar over the land surface. As a result, various forms of terrestrial and aquatic ecosystems have evolved. To provide a general understanding of the resulting milieu, some of the more dominant forces are discussed.

The geological history of this area spans at least the last 600 million years. Major events which have occurred and shaped the earth's surface include: the shifting, folding and faulting of large land masses; the denudation of the land surface by periglacial and nonglacial erosional processes; and the repeated partial invasion by ice during glacial epochs. Since these events have been predominantly regional in extent, the configuration and composition of the earth's crust is geographically distinctive. The northern Yukon consists of at least three dominant physiographic units. The bulk of the land mass is occupied by mountains which parallel each other along a northwestern axis. These mountains form a wedge which separates a coastal plain from an interior basin.

The climate for this vicinity is frequently termed 'subarctic continental'. The southern limit of this climate usually coincides with the poleward treeline or with a mean value of 10°C for the warmest month. As the temperature would suggest, the climate is rather severe; it is characterized by long winters with little daylight and by short summers with nearly continuous sunshine. The long periods of insolation compensate for the short growing season. The mean daily temperatures in the winter are commonly below -20°C, whereas those in the summer are above 3°C. This temperature regime promotes continuous permafrost conditions and a tundra plant cover. Precipitation at all times of year is light because of the predominance of cold air and the low absolute humidity. The total annual accumulation is often under 13 cm.

Cold temperatures, a short growing season and low rainfall have a marked effect on the plant life. The vegetation is largely *arctic tundra*, but this grades into less luxuriant *alpine tundra* with increasing elevation and into *taiga* or forest/tundra ecotone in the lower latitudes.

One of the world's largest caribou herds inhabits the northern Yukon. Other animals which are prevalent in the study area are grizzly bears, arctic fox, arctic ground squirrel, whistling swans, snow geese, other waterfowl, and a variety of shorebirds and passerines.

METHODOLOGY

Taken in the ecological sense, land consists of at least five interacting components: climate, terrain (soils and landforms), hydrology, vegetation and fauna. Because the constituent

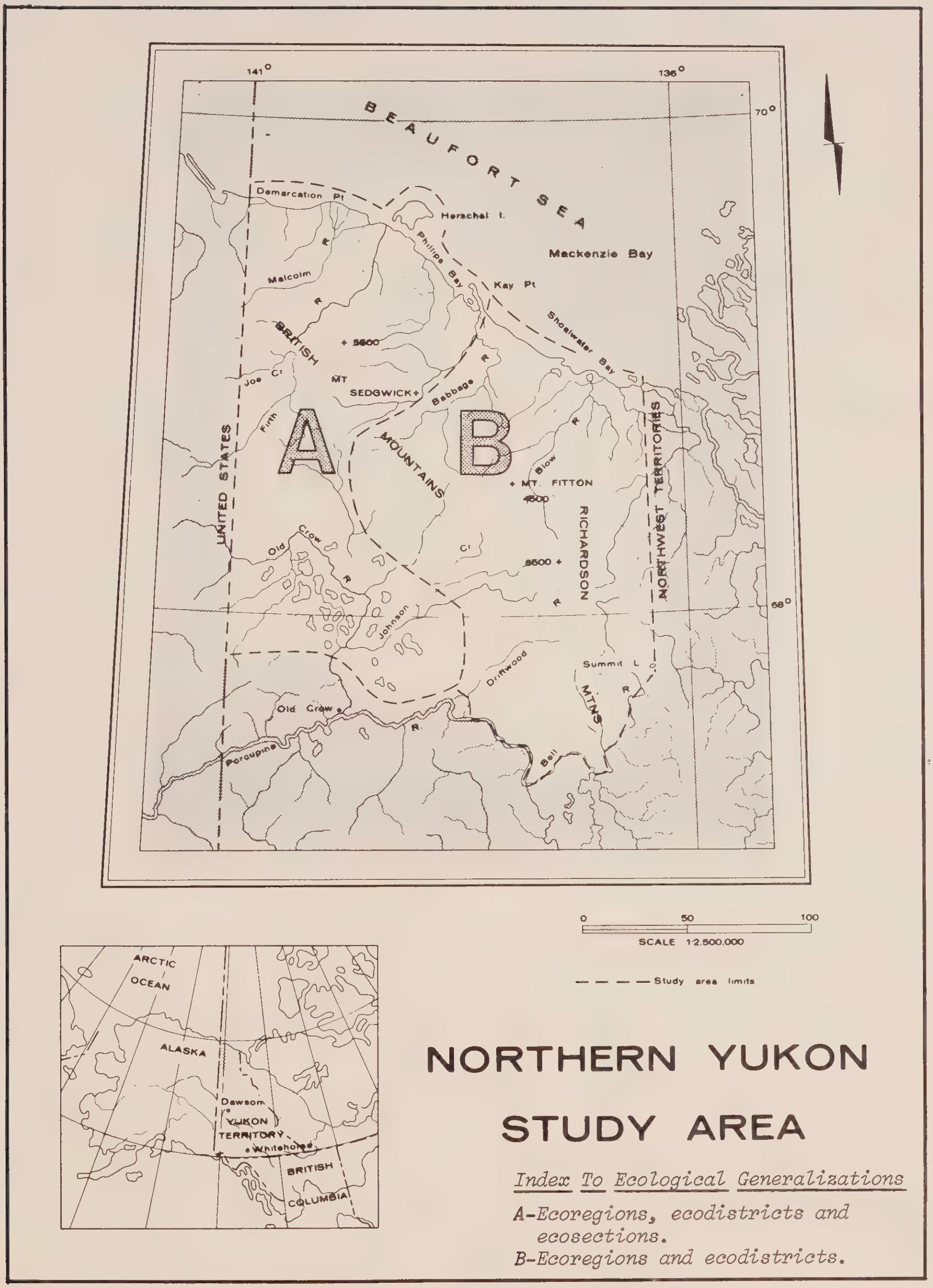


Figure 1 : Northern Yukon study area.

elements of each of these components vary geographically, land ecosystems acquire distinctive forms, ranging from large-scale generalizations such as the Boreal Forest or the Arctic Tundra to small-scale generalizations such as sloughs and meadows. Each form can be viewed as a functional tract of land having recognizable boundaries and internal unity of biological and physical characteristics. To account for the various levels of generalization, the ecological land classification approach professes to a hierarchic system to the mapping of land. In certain cases, the use of a hierarchy invokes a dichotomy of thought — to some, this means that land ecosystems are derived by logical division from above; to others, they are derived by assembling upwards from detailed observations. From a practical standpoint, there is often a little of both, as each route tends to substantiate or modify the results of the other alternatively throughout the classification process.

In obtaining an ecological data base for the study area, we have used three levels of generalization: the *ecoregion*, the *ecodistrict*, and the *ecosection*. The criteria employed to recognize each generalization were a function of existing data and the observations made during the exploratory field period. Because of time and access constraints some of the more idealized baseline data could not be secured.

For these three levels of generalization, we have, to a large extent, followed the traditional Canadian concepts of 'land region', 'land district' and 'land system'. To stress the notion that many ecological components interplay at all levels of generalization, we have substituted the prefix 'eco-' for 'land'. Hence, the terms 'ecoregion' and 'ecodistrict'. In addition to this change, we have substituted the work 'section' for 'system', and thus 'ecosection' instead of 'land system'. Since each level of generalization represents a system concept of land, it is awkward within the text or in dialogue to use 'land system' in a general sense as well as for a particular level of generalization.

In common, ecoregions, ecodistricts and ecosections are land ecosystems — areas of land which possess distinct commonalities. The distinctiveness is manifested in a recognizable ecological identity which is based on each land ecosystem's inherent and unified pattern of biological and physical characteristics. Aspects of pattern include, among others, process, composition, behaviour and response, and spatial relationships. Because process, as a pattern, has not been stressed (with perhaps the exception of vegetation chronosequence), we have attempted to stress this aspect of pattern in this report even though our survey is highly exploratory.

Consider, for example, the case of a small valley and interconnecting streams. In this situation, one normally finds the same process operating in the vicinity of each stream, assuming that the immediate environmental setting is similar. However, process is often linked to other and sometimes distant land ecosystems. For example, a large river which crosses a particular land ecosystem brings with it a hydrology and habitat which is largely independent, and often different from, the surrounding territory. The river and its sphere of influence are nonetheless a viable ecosytem, even though not being integrally tied into the broader pattern. Process is frequently implicit with the descriptors used to identify land ecosystems. For instance, the landform *pediment* implies several dimensions of process. It refers to the eroded wash slopes that rise toward the base of mountains and hills. These are low-pitched land surfaces which arise in relatively dry environments. The term also suggests that erosion and deposition result mainly from ephemeral streams. Another example is in the use of soil designations such as *cryosols*. These soils convey definite pedogenetic processes in which frost action and solifluction are major factors.

In conducting an ecological land survey, it is generally accepted that the knowledge from a number of disciplines must be involved in recognizing ecologically significant units of land. The recognition criteria used in this study are outlined briefly in Table 1. As with most classifications, the criteria are not entirely mutually exclusive, as each grades into the other.

The survey procedure essentially involves three phases: prefield, field and postfield. These phases overlap in the continuum of activities required to carry out an ecological land survey. The general procedure is illustrated with the ecodistricts.

Prefield work consisted of pretyping air photos and LANDSAT imagery with land ecosystem delineations, of gathering available and existing background information, of planning sites for field inspection, or having interdisciplinary dialogue and of proposing an overall work plan.

Field work allowed the survey team to verify the land ecosystems, which had been previously delineated. The first day of field work concerned a general overlfight of the study, using a fixed-wing aircraft. Over the next 8 days,

Table 1: Recognition Criteria for Northern Yukon Ecological Survey

Level of Generalization	Geomorphology	Soils	Vegetation	Climate	Water	Map Scale Used
ECOREGION	Regional forms and assemblage of regional forms	Assemblage of sub-groups	Plant regions	Macro- and/or meso-	Sub-basins and large river basins	1:1,000,000
ECODISTRICT	Assemblages of local forms and some regional forms	Assemblage of soil associations	Plant districts	Meso- and/or large micro-	Sub-basins and small watersheds. Assemblages of small and intermediate sized lakes.	1:500,000
ECOSECTION	Local forms and some assemblages of local forms	Soil associations and assemblage of soil associations	Plant associations	Large and/or small scale micro-	Subdivisions of large rivers. Small watersheds. Groups of small lakes.	1:250,000

a helicopter was used to gain access to 48 preselected sites, and a float plane was used to reach 5 other sites. The preselection of these 53 sites was done to minimize flight time, to obtain representative sites, and to pick sites which were near the interface of several land ecosystems. The latter allowed us to check several delineations at one stop. Owing to the constraints and objectives of the survey, we averaged one landing site per 650 km^2, one stop for each 69 km flown, roughly 7 stops per day and 30 minutes per stop. These stops allowed us to gather data and infill areas of uncertain knowledge.

Postfield work concerned the analysis of gathered data and the modifications of prefield descriptions and delineations. Also, dialogue among team members continued to be critical in assessing the accumulated knowledge of the survey area.

ECOREGIONS

Segments of four ecoregions extend into the northern Yukon study area. From the north and proceeding southward, these ecoregions are termed the *Northern Coastal Plain*, the *Northern Mountains*, the *Old Crow Basin*, and the *North Ogilvie Mountains*. Ecoregions in this area have been reported on in previous works (Zoltai and Pettapiece, 1973; Oswald and Senyk, 1977). Much of the material reported in our own report details and concurs with their findings, but modifications in boundaries and descriptions are introduced. Where possible, the existing names for ecoregions have been adopted to maintain continuity with the previous studies.

Ecoregions represent land areas that possess a recognized common identity from a regional perspective. In comparison, their subdivisions or parts — the ecodistricts and ecosections — are more inclusive and less variable with respect to biological and physical land characteristics. Commonalities of any one ecoregion are based on a unified pattern that expresses an integration of a particular kind(s) of regional climate, plant region, soil great group, regional landform and large scale aquatics. In certain cases, such as for the Northern Mountains Ecoregion, owing to cartographic convenience and the inherent variability of the land ecosystem, the ecoregion is a composite unit which represents more than one discrete entity. The distribution of the ecoregions is shown in Figure 2 and a description of one of the ecoregions follows.

Northern Coastal Plain Ecoregion

This is the most northerly of the four eco-

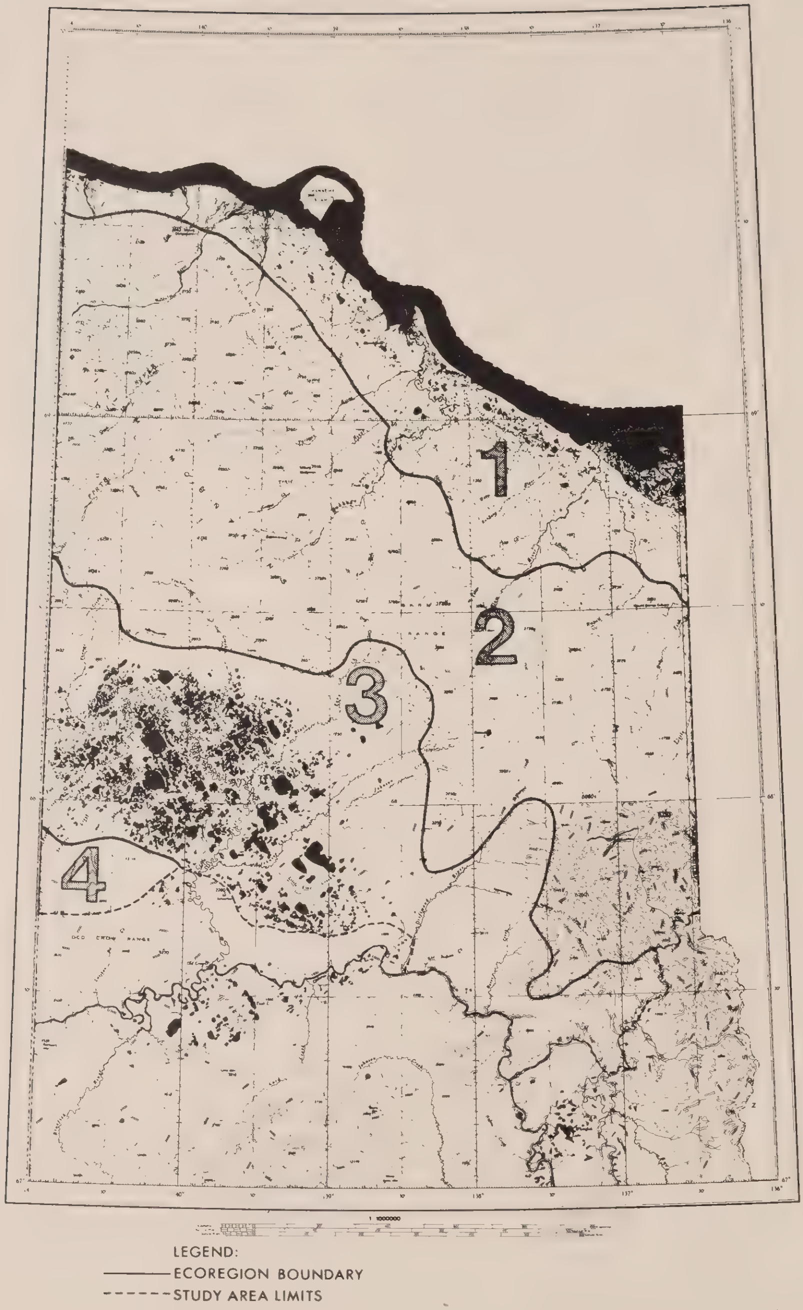


Figure 2 : Ecoregions: 1-Northern Coastal Plain, 2-Northern Mountains, 3-Old Crow Basin and 4-North Ogilvie Mountains.

regions and coincides in most respects with what is commonly referred to as the 'Arctic Slope'. Topographically, it is a gently bevelled surface averaging 20 km in width and sloping from the Northern Mountains interface, over a general elevational contour of 150 m, northwards to the Beaufort Sea coast. This irregular belt of low-lying terrain stretches for approximately 200 km from the northeastern tip of Alaska to the northwestern tip of the continental Northwest Territories. Prominent landmarks are absent and sheltered locales are rare and largely confined to the vicinities of river or stream entrenchment.

Along this monotonous plain, the depressions are usually infilled with organic materials and are etched into reticulate patterns by frost cracking. The upland and, to a lesser degree, the underlying surficial materials of the coastal plain have mixed origins, being derived from glacial and non-glacial processes. While bedrock exposures are very limited in occurrence, morainic, lacustrine and fluvial deposits are common. Their distribution is distinctive and two divisions of the plain can be recognized. Recent fluvial deposits, still in the process of formation, predominate on the plain west of Herschel Island, while to the east it consists of a rolling morainal plain interspersed with nearly flat areas of lacustrine materials. The two form a mosaic in which the moraine is dominant, especially towards the southern limits. Lacustrine deposits occupy topographical lows, and are blanketed by organics. Along the coastal fringe of this division, small lakes and ponds are typical occurrences. Rivers such as the Babbage and the Blow dissect this part of the plain by channels which have meandering and entrenched paths.

The maritime influence exerts a strong control over the climate of the coastal plain. The low water temperatures of the sea and the proximity to pack ice maintain generally low summer air temperatures along the coast. The inland penetration of this temperature regime is impeded by the foothills of the Northern Mountains Ecoregion. Since cold air holds little moisture, the precipitation is low in all seasons. The cold sea currents in conjunction with onshore winds also generate frequent fogs and occasionally heavy frosts in the summer period. While this ecoregion, like the others, is exposed to continuous daylight for close to four months, much of the insolation or heat energy in this particular area is curtailed by the presence of widespread fog which retards evapotranspiration and contributes to the pervading wetness of the soil. The overall cold climate and brief summers are reflected by the kinds of soils and vegetation.

Icy sediments and frozen soils (cryosols) are associated features. A shallow active layer, resulting from low heat accumulation, coupled with low evapotranspiration potentials, low surface gradients and fine-textured surficial materials, all act to impede surface drainage. Soils are consequently either gleyed or strongly mottled. These wet conditions limit oxygen supply and favor the accumulation of organic debris in surface horizons. In the topographical lows, this is most prominent as water remains at or above the surface for prolonged periods.

Vegetation of this ecoregion may be typified as being arctic tundra. Consequently, trees are absent and the vegetative cover consists primarily of tussocks of cottongrass interspersed with trailing and decumbent shrubs of Labrador tea, birch, bilberry and bog cranberry in upland positions and sedges and sphagnum mosses in the low-lying depressions. The predominance of trailing shrubs is likely the result of summer frost, the retardation of plant growth due to the persistence of cold air temperatures, and to the character of the cold frozen and wet soils.

ECODISTRICTS

Owing to the constraints under which this ecological land survey was conducted, the *ecodistricts* were considered the level of generalization which would have the most application in planning and management. While subdivisions of the ecodistricts are provided (ie. ecosections) for the western third of the study area, they were exploratory delineations which have not, for the most part, been checked or verified by ground truthing. As such, the working level was the ecodistrict and measures of decision making were recommended to parallel this level of generalization.

Ecodistricts are land ecosystems which were depicted on a 1:500,000 base map. According to biological and physical land characteristics, they have been generalized to coincide with areas of land having an ecological unified pattern consisting of various components such as: assemblages of local or, in a few cases, individual regional landforms; assemblages of soil associations; plant districts or, occasionally, plant regions; meso and large scale microclimatic areas; and sub-basins and small watersheds. Thirty-three ecodistricts were identified within the study area. Some of these are only partial units as many ecodistricts continue outside of the study limit boundary, some are composite land ecosystems (ie. complex or compound), and some are geographically isolated and equivalent to others. As an example of an ecodistrict, the description of the Komakuk

Plains is given.

Komakuk Plains Ecodistrict

In common with the entire Coastal Plain Ecoregion, the Komakuk Plains are characterized by their low altitude and subdued relief, and their abrupt termination along the foothills and pediments of the Northern Mountains Ecoregion (No. 2) to the south and the Beaufort Sea coast to the north. To the west, the Plains continue into Alaska, while eastwards there is a sharp change of geomorphology onto the King Plains Ecodistrict. This change marks the extreme westward extent of Quaternary glaciation. The Komakuk Plains are an unglaciated land, today covered by extensive fans and braided deltas of rivers originating in the Northern Mountains Ecoregion. In low-lying parts, there is a blanket of patterned organic materials underlain by marine sediments.

These Plains are plane! Although the ecodistrict slopes from 150 m asl to sea level from south to north, the local relief is negligile, of the order of a few metres over long, smooth slopes, and over the river banks of the large alluvial fans.

A further distinctive feature of the Komakuk Plains is the presence of aufeis (naleds or icings) on deltas of the Malcolm and Firth rivers. Aufeis is also present upstream on some of the rivers flowing into this ecodistrict. The Firth River especially has extensive aufeis upstream, most notably in the Joe Creek (2.05) and Riggs Mountain (2.07) ecodistricts. Icings are indicative of continued groundwater discharge throughout the winter, and moderated discharge and temperature fluctuations during the other seasons. Thus the icings and groundwater discharge are important for providing a year-round water supply for these rivers; this is critical for overwintering and summer migration and spawning of fish, particularly in the upper reaches of rivers.

A number of oriented, rectangular lakes occur in the northwest, straddling the Yukon/Alaska border. Such lakes tend to have depths of less than 3 m, shorelines of organic materials and an alignment which coincides with the dominant easterly and westerly surface winds. The coastline consists of low bluffs of rapidly eroding marine sediments. As with the entire northern Yukon coastline, massive ground ice is common in fine and organic sediments, and the melting of this permafrost is a major factor in producing rapid coastal retreat. The nature of the sediments precludes the presence of wide protective beaches. Instead, the silts and clays are deposited offshore, leading to shallow waters and the common grounding of ice floes. Where fluvial deposition occurs, the impact of sediment leads to a protrusion of the coastline, and the large particles of this sediment become eroded and transported to form prominent bars and spits, most notably the Nunaluk Spit towards Herschel Island. In the spring, beach sediments commonly contain buried and detached pieces of sea ice. In summer, this ice melts and leaves a curious potholing effect. Foredunes are another curious feature which develops in the beach area, leaving windthrown material along the upper edge of the beach escarpment.

Soils in general are poorly weathered throughout the Plains. Much of this results from the shallow depth to continuous permafrost and the presence of free water in the surface active layer for prolonged periods. These soils are characterized as being acid and nutrient poor. Equally, they tend to be rich in organic material since plant material accumulates and little decomposition occurs. Low soil temperatures, low near-surface air temperatures, and wet and frozen conditions are typical. Many of these attributes apply as well to the Herschel Island and King Plains ecodistricts.

Rivers and streams strongly influence the vegetation of the Komakuk Plains Ecodistrict. Spring floods cover extensive areas, leaving large portions of these deltas bare of vegetation. For the inactive portions of these deltas which are not affected by the spring runoff, vegetation has become established and consists predominantly of *Carex microchaeta*, *Eriophorum Scheuchzeri* and other sedges along with scattered trailing and decumbent *Salix* spp and some *Sphagnum* spp. Scattered elevated locales of vegetation within this area are characterized by *Ledum palustre* ssp *decumbens*, *Vaccinium vitis-idaea*, *Betula nana*, *Aulacomnium turgidum* and other species typical of better drained situations.

The area between Fish Creek and Clarence Lagoon contains expanses of tussock tundra dominated by *Eriophorum vaginatum*, *Ledum palustre* ssp *decumbens*, *Vaccimium vitis-idaea*, *Betula nana* and *Sphagnum* spp.

The organic terrain has vegetation which is peculiar to the type of polygon which is present. Low-center polygons, which predominate, have cores covered by sedges and *Sphagnum* spp along with trailing forms of *Ledum palustre* ssp *decumbens*, *Andromeda polifolia*, *Vaccinium vitis-idaea*, *Salix* spp and *Betula nana* forming the elevated rims. High-center polygons have tussocks of *Eriophorum vaginatum*, along with

Ledum palustre ssp *decumbens, Vaccinium vitis-idaea, Betula nana and Sphagnum* spp on the elevated central portions and largely *Carex aquatilis* and *Eriophorum angustifolium* in the ice-wedge troughs which form the matrix.

SUPPLEMENTARY INFORMATION

Information on outstanding phenomena, wildlife, and the recent history of man was derived from field observations, from interpretation of aerial photographs, and from other publications dealing with the study area.

Outstanding Phenomena

In any attempt to outline the outstanding phenomena of the northern Yukon, clichés and superlatives are very difficult to circumvent, as the area has numerous features which make it of special significance. This is evidenced by a vast range of interest groups, which includes federal agencies such as the Canadian Wildlife Service and Parks Canada, and a host of organizations such as the International Biological Program (Nettleship and Smith, 1975; Beckel, 1975), the World Heritage Convention of UNESCO (Bennet, 1977), the Canadian Arctic Resources Committee (CARC), the Inuit Tapirisat, the Arctic International Wildlife Range Society (Calef, 1974), the Mackenzie Valley Pipeline Inquiry, the Alaska Highway Pipeline Panel, and the Committee for Original Peoples' Entitlement (COPE).

'Outstanding' was used in a broad context to cover phenomena which had intrinsic ecological value and specific scientific or educational use. The distinction of being outstanding was also weighted by perspective (ie. regional, national or international). Phenomena were identified through exploratory overflights of the area, through personal communication with previous investigators of the area, and from the literature. Where possible, phenomena were related to ecological uits of land (ecoregions or ecodistricts). The description of the ecodistricts of the Old Crow Basin Ecoregion are exemplary.

The *Old Crow Flats Ecodistrict*, which covers roughly 4,000 km^2, is a spectacular wetland area which includes hundreds of lakes of various kinds. Many of the larger lakes are square or rectangular and oriented in a northwest/southeast direction. A number of theories have been proposed regarding the origin of these *oriented lakes*. Price (1968) describes them as being due to subsidence over fault or fissure blocks. He feels that the 'fault-block origin' is supported by the large, square drainage patterns with which the lakes are associated and in the squares in which most of the lakes lie. Many other lakes of the ecodistrict are clearly the remains of larger in-filled oriented lakes. Still other lakes of the Old Crow Flats Ecodistrict are of fluvial origin. Whereas all rivers and streams of the ecodistrict meander, the meanders of the *Old Crow River* are particularly pronounced along its full length. This has led to the formation of innumerable *oxbows* and *oxbow lakes* and some *multiple oxbow lakes* where lakes are in contact. In some cases, rather long stretches of meandering channel have been cut off from the main stream, leaving snake-like *serpentine lakes*. A fourth type of lakes, which appear to be of the thermokarst variety, are also widespread and numerous in the ecodistrict. These lakes are typically small, roundish and form dense patterns. They may have been formed by the melting of blocks of ice which formed in permafrost prior to Quaternary glaciation. Regardless of the origin of lakes in the Old Crow Ecodistrict, all lakes are very shallow (less than 2 m deep) and have bottoms of organic debris.

Pediments are a recognized feature of unglaciated arid and semi-arid areas. They are conventionally associated with hot, desert climates of the mid-latitudes, rather than with dry, polar environments. Since the majority of Canada has been glaciated, and as very little can be considered arid or semi-arid, pediments are widespread in the unglaciated intermountain areas of the northern Yukon, and vast, uninterrupted pediment plains exist in the Old Crow Pediments Ecodistrict. A particularly impressive pediment is located in the northeast portion of the ecodistrict between Black Fox and Johnson creeks. The pediment is further enhanced by the feather-like drainage pattern which etches the furface. The sharp contrast between the willows and aquatic sedges of the drainageways and the predominately tussock tundra matrix of this portion of the ecodistrict is prominent on aerial photographs and from the air.

Wildlife

The northern Yukon, perhaps the most diverse and productive area of Canada's Arctic, supports many wildlife species in a wide range of habitats. We discussed those wildlife species, for which sufficient data were available, and their use of the land ecosystems defined within the study area. Information was taken primarily from studies concerned with the potential environmental impact of petroleum exploration and pipeline construction in the northern Yukon. Emphasis was placed on extracting data which dealt with wildlife distribution, abundance, and the definition of habitats within the study

area. Within the report, caribou, arctic fox, bears, moose, waterfowl, etc. are covered. Waterfowl are used as an illustration.

Waterfowl: While the main emphasis here was on the habitat of waterfowl, the areas of concern to shorebirds as well as other birds were noted. Two major and geographically separated areas in the northern Yukon are important to waterfowl and shorebirds. One is the Northern Coastal Plain Ecoregion and the other is the Old Crow Flats Ecodistricts. These two areas are approximately 120 km apart, lying on either side of the mountainous divide of the Northern Mountains Ecoregion.

Within the Northern Coastal Plain Ecoregion, the shore zone and inland water bodies are of particular significance. The peninsulas, barrier beaches, lagoons, spits, river deltas and islands, and sandbars along the coastline are used as molting areas during the summer by a large number of sea ducks. Herschel Island, for example, supports a population of roughly 10,000 sea ducks during the moulting period (Gollop and Davis, 1974). At other times of the year, such as the late summer and fall, the same shore zone areas are used as staging grounds for ducks, geese, loons, and shorebirds. The coastal area and river deltas from the mouth of the Blow River west to the Canning River in Alaska are, in particular, the fall staging grounds for several hundred thousand Snow geese as well as smaller populations of Black Brant, White-fronted and Canada geese and Whistling swans (Koski, 1975; Schweinsburg 1974). From the delta areas, these birds range inland to the foothills of the northern mountains where they feed on sedges and berries in preparation for the long southward migration (Koski, 1975; W. Speller, pers. comm.).

Inland from the coastline proper, the shallow lakes of the King Plains Ecodistrict are the feeding and breeding habitat for waterfowl, loons, and shorebirds. In a survey of 22 lakes, Gollop and Davis (1974) found that 14 supported broods of waterfowl. Of the surveyed lakes, the larger-sized supported more shorebirds and arctic terns and have a generally greater species diversity. The productivity of shoreline vegetation and the slope of the foreshore were critical factors in determining the suitability of these lakes for waterfowl and shorebirds. Lakes having productive riparian vegetation and gently sloping banks were the most suitable habitats for these birds.

The Northern Coastal Plain Ecoregion is part of a major two-way migration corridor. Observations of Nunaluk Spit in the Komakuk Plains Ecodistrict revealed that well over 200,000 birds of 58 species migrated past this location alone. The peak time for these birds was the interval between 21 August and 10 September (Gollop and Davis, 1974). From other studies (Schweinsburg, 1974), the species using this corridor have been estimated as: 32% waterfowl, 31% shorebirds, 18% gulls and terns, 14% Lapland longspur and other song birds, and 5% other birds. These figures indicate the diversity of species which migrate through this region.

In contrast to the Northern Coastal Plain Ecoregion, the Old Crow Flats Ecodistrict occupies the floor of an interior basin. This ecodistrict is a lake-dominated surface; it provides nesting, feeding, molting, and staging habitat for hundreds of thousands of aquatically dependent waterfowl and shorebirds. As in the King Plains Ecodistrict, the lakes most heavily used by waterfowl are those possessing the most favourable combination of shoreline topography and vegetation. With respect to its importance to waterfowl populations, this area is on an equal footing with the Northern Coastal Plain and the Mackenzie Delta areas. Its major function is in providing habitat for large numbers of surface feeding and diving ducks. Upwards of 300,000 breeding pairs nest here. In addition, large numbers of non-breeding ducks also exploit the Old Crow Flats. During drought years on the prairies, the numbers of ducks on the Flats can double (F. Cooch, pers. comm.) thus giving the area an even greater role in maintaining national and international waterfowl populations.

Recent History of Man

This is the third major interpretative part of the Yukon study. Since the survey area is largely a noncultural landscape, man has not played a major role in shaping or modifying this environment.

The Kutchin Indians (now known as Loucheux) traditionally fished for salmon and freshwater fish in summer and hunted moose, caribou, hare and other game in winter (Harding, 1976). During spring and fall, they hunted migrating caribou at river crossings, and, in the British Mountains, funnelled caribou into corrals via long fences of spruce trees (remains of several Kutchin fences still exist, some of which are over three km long and built of thousands of stunted spruce trees). This subsistence lifestyle changed very little throughout the prehistoric periods.

The period from about 1870 included the abandonment of Klo-kut, a site located on the north bank of the Porcupine River about 10 river km

upstream of the village of Old Crow (Morlan, 1975). During the brief gold rush period of the turn-of-century, many Kutchin Indians went south to trade meat to the miners. When the rush ended, many moved to the Mackenzie Delta to trap muskrats near the trading posts; most of the remaining Indians began to gather at the junction of the Porcupine and Old Crow rivers, a traditional river crossing for migrating caribou and, for years, the site of a hunting camp (Harding, 1976). Here the present village of Old Crow developed.

Old Crow is presently the most northerly permanent settlement in the Yukon Territory, and is home to over 200 Loucheux Indians who live predominantly by fishing, hunting and trapping. Fish catches, which may reach 10,000 salmon and 3,000 freshwater fish annually, continue to be important in the Loucheux culture (Harding, 1976). Besides their use for human consumption, fish are the principal food for sled dogs, which provide winter transportation for hunting and trapping. Caribou, which are hunted in the fall when the animals migrate southward to their winter range, along with moose and waterfowl, also provide food for the Old Crow people. 'Ratting', the annual spring muskrat hunt on the Old Crow Flats, is also important as it provides cash from the sale of fur, as do sales of furs of fox, lynx, mink, marten and wolverine. The annual muskrat hunt is also very important to the Old Crow people as it has traditionally been a family outing where young and old work and live together outdoors in the flats. The continuance of this traditional subsistence way of life of the Old Crow residents indeed depends heavily on the northern Yukon's wildlife resources and the ecosystems which they inhabit.

SUMMARY

Despite a paucity of field observations, the Northern Yukon Study was able to draw upon existing single disciplinary stusies. This particularly includes information gathered for the Northern Coastal Plain and Old Crow Basin areas as part of the Environmental-Social Program Northern Pipelines Series and the Arctic Gas Biological Report Series. In most instances, we were able to synthesize data from the other sources with our own data to provide a fairly comprehensive view of the land ecosystems of the northern Yukon. At each level of generalization — ecoregion, ecodistrict and ecosection — all aspects of land ecosystems were considered, rather than solely eg "regional climate as expressed by vegetation", or "distinctive pattern of relief, geology, geomorphology and associated regional vegetation" as has traditionally been the case in ecological land surveys. This paper attempts only to give an overview of the study — its aims, methodology, and sample ecological generalizations and interpretations. These aspects are expanded upon in much more detail and are enhanced, by means of additional text, maps, tables, figures, plates, appendices and an extensive bibliography, in the study group's report to Parks Canada. We expect to publish the results of this study in the Ecological Land Classification Series in 1979.

REFERENCES

Beckel, D.K.B. (ed.). 1975. IBP Ecological sites in Subarctic Canada. Panel 10. Int. Biol. Prog. Univ. of Lethbridge, Lethbridge, Alta.

Bennet, P.H. 1977. What is the World Heritage Convention? Can. Geog. J. 93: 22-29

Calef, G.W. 1974. The urgent need for a Canadian Arctic Wildlife Range. Nature Canada 3(3): 3-11.

Gollop, M.A. and R.A. Davis. 1974. Studies of bird populations and productivity on lakes on the Yukon north slope, July 1972. Arctic Gas Biol. Rept. Ser., Vol. 12. Can. Arctic Gas Study Ltd., Calgary Alta. 35 p.

Harding, L. 1976. What are we doing to the northern Yukon? Can. Geog. J. 92(1):36-43.

Koski, W.R. 1974. Study of the distribution and movement of snow geese, other geese and whistling swans on the Mackenzie Delta, Yukon north slope, and Alaskan north slope in August and September 1975. Arctic Gas Biol. Rept. Ser., Vol. 30, Chap. 1. Can. Arctic Gas Study Ltd., Calgary, Alta. 58 p.

Morland, R.E. 1975. Kutchin prehistory, as seen from the middle Porcupine drainage, Northern Yukon Territory. Nat. Mus. Can. 2(27): 669-758. Ottawa.

Nettleship, D.W. and P.A. Smith (eds.). 1975. Ecological sites in Northern Canada. Can. Comm. for the Int. Biol. Prog.

Oswald, E.T. and J.P. Senyk. 1977. Ecoregions of the Yukon Territory. Can. For. Serv., Envir. Can. Publ. BC-X-164. 115 p.

Price, W.A. 1968. Oriented lakes, p. 784-796 *in* Encyclopedia of Geomorphology. (R.W.

Fairbridge, ed.). Encyclopedia of Earth Sci. Vol. III. Dowden, Hutchison and Ross, Inc., Stroudsburg, Penn.

Schweinsburg, R.E. 1974. An ornithological study of proposed gas pipeline routes in Alaska, Yukon Territory, and Northwest Territories, 1971. Arctic Gas Biol. Rept. Ser., Vol. 10. Can. Arctic Gas Study Ltd., Calgary, Alta. 215 p.

Wiken, E.B., D.M. Welch, G. Ironside, D.G. Taylor and J. Thie. 1978. The northern Yukon: An ecological land survey. Prepared for Parks Canada by the Ecological Land Classification and Evaluation Division, Lands Directorate. 288 p.

Zoltai, S.C. and W.W. Pettapiece. 1973. Studies of vegetation, landform and permafrost in the Mackenzie Valley: terrain, vegetation and permafrost relationships in the northern part of the Mackenzie Valley and Northern Yukon. Environmental-Social Prog. Nor. Pipelines, Task Force on Nor. Oil Devel. Rept. 73-4. Ottawa. 105 p.

ECOLOGICAL LAND CLASSIFICATION PROJECTS IN NORTHERN CANADA AND THEIR USE IN DECISION MAKING

S. C. Zoltai
Canadian Forestry Service
Environment Canada
Edmonton, Alberta

ABSTRACT

Ecological land classification project, where a range of environmental parameters rather than single discipline approaches were used, have been undertaken in northern Canada. Although the studies were not coordinated, almost all used the ecoregions and their broad subdivisions, ecodistricts. Mapping criteria included parent materials, relief, vegetation, soils, and drainage. Most projects were intended as baseline studies prior to development. One project, in the Mackenzie Valley, went through the appraisal and final decision process. Ecological land information was used to identify possible impacts along the pipeline route.

RÉSUMÉ

Divers projets de classification écologique du territoire ont été réalisés dans les régions septentrionales du Canada. La formule adoptée faisait intervenir toute une gamme de paramètres environnementaux plutôt que des disciplines uniques. Bien que non coordonnées, les études ont pour la plupart été axées sur les écorégions et leurs grandes subdivisions, les districts écologiques. Le matériel-mère, le relief, la végétation, les sols et le mode de drainage constituent les éléments cartographiés. Les travaux de recherches étaient pour la plupart des études de base préalables à des projets de développement. Une étude entre autres, visant la vallée du Mackenzie s'est rendue jusqu'à l'étape finale du processus d'évaluation et de décision. Les renseignements sur l'écologie du territoire ont servi à déterminer les incidences possibles du pipeline sur l'environnement, le long du trajet choisi. (Trad. Éd.)

INTRODUCTION

Northern Canada, lying north of the 60th parallel, comprises nearly 40% of the country. This vast area, nearly 4 million km^2 (over 1.5 million mi^2) displays a wide variety of physiography from the highest mountain in Canada to featureless plains. Permafrost, continuous over all but the southwestern part of the area, creates unique soil conditions. The harsh climate causes nearly barren areas in the far north, varying through treeless, but otherwise well vegetated shrub and grass tundra to stunted subarctic forests and to closed-canopy boreal forests in the south.

In the north the value of vegetation is often not readily apparent. Although commercially exploitable timber grows in the southern Yukon and Mackenzie Valley, timber values elsewhere are negligible. Wood may be locally utilized for fuel or building materials, but the main value of the vegetation lies in its role as part of the environment. In the Subarctic, moss effectively insulates the ground, preserving the permafrost and the integrity of the terrain. Disturbance of the living vegetation will result in summer thawing of the ground, which releases large amounts of water and mud. Vegetation provides food and shelter to wildlife, often the only harvestable resource of the north.

Under northern conditions a land classification program stressing the productivity of the land is inadequate. The land-vegetation relationships must be examined from both the engineering and environmental aspects to produce ecological units meaningful to all disciplines. Various investigators have tried different methods of integrating the information into ecologically meaningful units. In this paper the approaches used in recent ecological land classification programs in the Northwest Territories are outlined, and their similarities and usefulness in the decision making process by land managers are evaluated. This paper is largely based on material presented at a symposium on Ecological Land Classification (Zoltai 1977).

ECOLOGICAL SETTING

A brief introduction into the ecological setting of northern Canada is provided by the Ecological Regions ("Land Regions" of Subcommittee on Biophysical Land Classification, 1969; "Site Regions" of Hills, 1961; "Biogeoclimatic Zones" of Krajina, 1972). In all cases the regions were characterized by examining the

Figure 1: Provisional Map of Ecological Regions in Northern Canada

LEGEND

A_H -- High Arctic
A_M -- Mid Arctic
A_L -- Low Arctic

S_{Hw} - High Subarctic, west
S_{He} - High Subarctic, east
S_L - Low Subarctic

A_{Hx} - High Alpine Complex
A_{Mx} - Mid Alpine Complex
A_{Lx} - Low Alpine Complex

S_{Hx} - High Subalpine Complex

B_H - High Boreal
B_{Hd} - High Boreal, dry

Table 1: Brief characteristics of the Ecological Regions of the Northwest Territories and Yukon.

High Arctic (AH)	Scattered vegetation (less than 50% ground cover) of perennial herbs, dwarf shrubs, mosses, and lichens. Continuous permafrost.
Mid Arctic (AM)	Discontinuous vegetation (50-90% ground cover) of low shrubs, perennial herbs, mosses, and lichens. Continuous permafrost.
Low Arctic (AL)	Complete ground cover of shrubby lichen-heath tundra. Continuous permafrost.
High Subarctic (SHw) (West)	Open-canopied, stunted black spruce-shrub-lichen forest (white spruce near tree lines). Continuous permafrost in mineral soils, discontinuous in peatlands.
High Subarctic (SHe) (east)	As in west, but with large expanses of Low Arctic tundra.
Low Subarctic (SL)	Open-canopied, black spruce-lichen forests. Permafrost widespread, but discontinuous in mineral soils and in peatlands.
High Boreal (BH)	Closed canopy forests of aspen-spruce-feathermoss. Sporadic permafrost in imperfectly drained mineral soils and in peatlands.
High Boreal (BHd) (dry)	Low rainfall area with open stands of white spruce and lodgepole pine. Sporadic permafrost in peatlands.
MOUNTAIN COMPLEXES	
High Alpine Complex (AHX)	Dominantly resembles High Arctic regions, but lower slopes and valleys resemble Mid and Low Arctic regions.
Mid Alpine Complex (AMX)	Dominantly resembles Mid Arctic regions, but with higher peaks resembling High Arctic, and low valleys resembling Low Arctic and High Subarctic regions.
Low Alpine Complex (ALX)	Dominantly resembles Low Arctic regions, but some higher peaks resembling Mid Arctic regions, and some valleys resembling High Subarctic regions.
High Subalpine Complex (SHX)	Dominantly resembling High Subarctic regions, but with peaks resembling Low Arctic regions, and valleys resembling Low Subarctic regions.

undisturbed vegetation on well-drained soils on a gentle slope having adequate nutrients (normal sites, Hill 1961). Brief descriptions of Ecological Regions are given in Table 1, and a provisional map of the Northwest Territories and the Yukon is shown in Figure 1.

ECOLOGICAL LAND SURVEYS

Ecological land surveys conducted in the Northwest Territories in the past were influence by two main factors. The dominant one was the fact that nearly all were instituted in reaction to proposed developments in the north, mainly pipelines. This meant that because of the urgency and short term of the projects, proper planning and development of priorities and methodologies were often not possible. The second factor was the great expense associated with northern field work because of the remoteness from supply points and the total dependence on air transportation.

The result of such pressures was that in most cases the lead agency (controlling the mapping methodology, field operations, and logistics) was in the discipline of Pleistocene geology (Terrain Sciences, Canada Department of Energy Mines and Resources). Members of other disciplines, such as plant ecologists, botonists, pedologists, and wildlife biologists, were attached to the terrain scientists, sometimes as an integral part of the term, but often as an afterthought. Thus, some of the resulting maps were based entirely on geomorphological features, with ecological characterization added.

Seven of the recent studies were related to various pipeline proposeals (Figure 2): Mackenzie Valley (Hughes et al., 1972a, b; Rutter et al., 1972; Tarnocai, 1973; Zoltai and Pettapiece, 1973; Hanley et al., 1975), Mackenzie Valley south (Crampton, 1973), eastern Melville Island (Barnett et al., 1975, 1976a; Barnett, 1976), Bathurst and Cornwallis islands (Barnett et al., 1976b; Tarnocai, 1976), Boothia Peninsula and northern Keewatin (Tornocai and Boydell, 1975; Tarnocai et al., 1976; Tarnocai and Netterville, 1976), central Keewatin (Tarnocai, 1977), Somerset Island and northern Prince of Wales Island (Zoltai and Woo, 1976; Woo and Zoltai, 1977). Two studies were made of potential national park sites: South Nahanni River (Scotter et al., 1971) and Fort Reliance-Artillery Lake (Kelsall et al., 1970). One project dealing with caribou rangelands is under way in the Great Slave Lake area, but will not be considered here because no reports are available.

The purpose of all but two studies was to provide baseline information on terrain and environmental characteristics for the assessment of pipeline development proposals. Consequently, those aspects that affect the engineering performance of the terrain or that supply granular materials for construction were stressed. However, as the role of vegetation in preventing thermal erosion became clear, and as ecologically sensitive areas were encountered, biological studies became part of the mapping projects. Thus, biological information was present only as additional characterization of the mapping units in the early studies (Mackenzie Valley), but later, vegetation and soils aspects also became mapping criteria, along with the geomorphological features. In the two projects oriented toward providing information on the natural environment of potential national park areas, the large scale mapping (1:50,000) permitted the production of separate terrain and vegetation maps.

METHODOLOGY

Because the projects were initiated at different times and at different locations and by different government organizations, there was no opportunity for applying any one classification system. It is interesting to note, therefore, the similarities in the classification approaches (Table 2).

All but two studies divided their area into broad regions (level 1) on the basis of climate. The two that did not (Table 2, studies 3 and 4) were studying areas that were entirely in the same climatic region. The main criterion for this broad regionalization was climate as reflected by the distribution growth, and successional trends of vegetation communities. Some studies included such climatically controlled factors as the occurrence of dominant Great Soil Groups or soil genesis and the distribution pattern of permafrost.

The next lower level (2) of detail was handled differently by some of the investigators. Most studies used the Land District concept of the Biophysical Classification (Subcomm. 1969), in which the districts are recognized as areas of broadly similar patterns of geomorphological and geological features and soil parent material and permafrost conditions. Vegetation distribution would also follow a recognizable pattern within the climatic region. On some of the Arctic islands the bedrock formations were taken as the corresponding level of subdivision. This was prompted by the virtual absence of glacially transported materials: the surface materials therefore reflected the underlying bedrock. In the southern Mackenzie study the parent material was used to distinguish areas at this level of detail.

Figure 2: Ecological Land Classification Projects in the Northwest Territories

LEGEND

1. Mackenzie Valley
2. Southern Mackenzie Valley
3. Eastern Melville Island
4. Bathurst and Cornwallis Islands
5. Boothia Peninsula and Northern Keewatin
6. Central Keewatin
7. Somerset and Rince of Wales Islands
8. South Nahanni River
9. Fort Reliance - Artillery Lake

Table 2: Ecological Land Classification in Northern Canada

STUDY	DISCIPLINES (lead)	LEVEL 1		LEVEL 2		LEVEL 3		ADDED INFORMATION
		NAME	CRITERIA	NAME	CRITERIA	NAME	CRITERIA	
1. Mackenzie	<u>Pleistocene Geology</u> Soils Vegetation	Land Zone Ecological Zone	bioclimate permafrost			Map Unit	material thickness topography drainage pattern	soil texture permafrost drainage vegetation association
2. South Mackenzie	<u>Geography</u>	Land Region	bioclimate soil genesis permafrost	Land District	soil texture	Land System	relief material vegetation permafrost	
3. East Melville Island 4. Bathurst and Corwallis Is.	<u>Pleistocene Geology</u> Vegetation Mammals Soils			Landscape Type	bedrock formation marine limit	Terrain Unit	morphology relief drainage material weathering products	vegetation communities mammals birds
5. Boothia Peninsula 6. Central Keewatin	<u>Pleistocene Geology</u> Soils Vegetation	Ecoregion	bioclimate soil genesis	Eco-district	physio-graphic pattern& material	Ecoarea	material origin relief soil vegetation	
7. Somerset Is.	<u>Pleistocene Geology</u> Soils Vegetation	Ecoregion	bioclimate soil genesis	Eco-district	physio-graphic pattern& material	Soil Assoc.	material relief soil drainage vegetation	
8. South Nahanni 9. Great Slave - Artillery Lakes	<u>Wildlife</u> Vegetation Pleistocene Geology	Vegetation Zone	bioclimate			Vegeta-tion Type Terrain Unit	vegetation communities material relief origin	

At the mapping level (3) all studies used parent mate ials and relief as criteria. In some biophysically oriented studies vegetation, soils, and internal drainage were included in the mapping criteria. In some studies additional criteria were the geological origin of the surficial material and permafrost conditions.

Under arctic conditions, where catastrophic disruptions of the vegetation (fire, clearing, etc.) are rare, the existing vegetation reflects the vegetation communities best adapted to each kind of land surface. The physiographic conditions, such as parent material, nutrient status, soil moisture, active layer depth, slope, aspect, etc. will result in distinctive vegetation and soil conditions within climatic zones. The understanding of such interrelationships between the terrain and vegetation allows the plant ecologist to make use of physiographic information for an ecological land classification.

USE OF ECOLOGICAL LAND CLASSIFICATION STUDIES

Two studies were oriented toward the initial evaluation of potential national parks. The information was used by park planners and in preselection publicity to highlight scenic or outstanding features of the two areas. In addition, the study was used in the Fort Reliance-Artillery Lake area to justify the size of the proposed park, including both summer and winter ranges of caribou. The South Nahanni area was subsequently developed into a natural park, but the Fort Reliance-Artillery Lake area was rejected, chiefly due to objections by native groups.

All of the other studies were oriented toward the assessment of possible environmental impact of two proposed pipeline projects, one in the Mackenzie Valley and one from the Arctic Islands through the District of Keewatin, west of Hudson Bay. At the present time both proposals have been formally submitted, but only the Mackenzie Valley proposals went through the environmental impact assessment process. All remarks will, therefore, be directed toward the assessment of the Mackenzie Valley pipeline proposals.

During the years preceeding the submission of the proposals, both the proponent and government agencies conducted environmental studies in the broadly defined Mackenzie Corridor. The location of the proposed pipeline was based on studies by the proponent and did not become publicly known until the submission of the proposal. Government studies, therefore, did not influence the route selection.

The assessment process involved several groups. The Environment Protection Board, an independent group sponsored by the major pipeline proponent, did not conduct ecological land studies, nor did it use the studies conducted by government agencies for its impact assessment (Environment Protection Board, 1974). The federal government established two assessment groups: the Pipeline Application Assessment Group, concerning itself with the environmental and socioeconomic impact of the proposal, and a regional environmental task force, looking into the environmental impact only. Both groups made full use of the available environmental land information (Pipeline Application Assessment Group, 1974; Department of Environment Task Force, 1975).

The ecological land classification studies, along with other studies, were submitted to the Mackenzie Valley Pipeline Inquiry. In addition, individuals involved in the ecological land studies testified at the formal hearings of the inquiry as expert witnesses. These studies and testimony contributed to the discovery and substantiation of several serious environmental concerns.

The Mackenzie Valley experience showed the serious lack of knowledge of land-vegetation relationships in northern Canada. The results of the studies were urgently needed, giving rise to uncoordinated efforts. By the time the results were emerging, they could only be used in the final assessment process, as it was too late to influence the initial route selection. The same situation obtained for the proposed Polar Gas route in the Arctic Islands and Keewatin, where again only quick, ad hoc studies could be made.

These experiences highlighted the need for a broad ecological overview study of northern Canada. In this, the Land Regions (or Ecoregions), as well as the main Land Districts can be determined. A tentative Land Region map is presented in Figure 1, based on localized regional studies. The broad land-climate-vegetation relationships, presently lacking from large parts of the Arctic, would be established at this level. Should another Mackenzie Valley situation arise in Northern Canada, such background information would only need filling out by detailed, local studies, thereby avoiding duplication, panic, and waste of resources and manpower.

REFERENCES

Barnett, D.M. 1976. Eastern Melville Island: Biophysical aspects of a geological survey reconnaissance mapping program. pp. 153-158 *in:* Proc. 1st. Meeting Can. Comm. Ecol. Land Classif. (Comp. and ed. by J. Thie and G. Ironside) Ecol. Land Class. Ser. No. 1 Lands Directorate, Environment Canada, Ottawa.

Barnett, D.M. S.A. Edlund, L.A. Dredge, D.C. Thomas, and L.S. Prevett. 1975. Terrain classification and evaluation, Eastern Melville Island, N.W.T. Geol. Surv. Can. Open File No. 252. 1318 p.

Barnett, D.M., S.A. Edlund and L.A. Dredge. 1976a. Terrain characterization and evaluation: an example from Eastern Melville Island. Geol. Surv. Can. Paper 76-23.

Barnett, D.M., L.A. Dredge, and S.A. Edlund. 1976b. Terrain Inventory: Bathurst, Cornwallis and adjacent islands, Northwest Territories, Geol. Surv. Can. Paper 76-1, Pt. A, 201-204.

Crampton, C.B. 1973. Landscape survey in the upper and central Mackenzie Valley. Environ. -Soc. Comm. North. Pipelines, Task Force North: Oil Dev., Rep. No. 73-8, 67 p.

Department of Environment Task Force. 1975. Report of the D.O.E. Task Force on the Mackenzie Valley pipeline application. Vol. I, North of 60°. Can. Dep. Environ., Environ. Manage. Serv. Edmonton, 41 p.

Environment Protection Board. 1974. Environmental impact assessment of the portion of the Mackenzie gas pipeline from Alaska to Alberta. Vol. I, 77 p.; Vol. II, 20 p.; Vol. III, 12 p.; Vol. IV, 307 p.

Hanley, P.T., S.C. Chatwin, O.L. Hughes, and J. Pilon. 1975. Surficial geology, District of Mackenzie, N.W.T. (Mapsheets 96 E, F, 106 p). Geol. Surv. Can., Open File No. 294.

Hills, G.A. 1961. The ecological basis for land-use planning. Ont. Dep. Lands for., Res. Rep. No. 46. 204 p.

Hughes, O.L., D.A. Hodgson, and J. Pilon. 1972a. Terrain maps, Mackenzie Valley (Mapsheets 105 I, M, and N). Geol. Surv. Can., Open File No. 97.

Hughes, O.L., D.A. Hodgson, and J. Pilon. 1972b. Surficial geology maps, Mackenzie Valley (Mapsheets 106 J, K, and O). Geol. Surv. Can., Open File No. 109.

Kelsall, J.P., E. Juyt, and S.C. Zoltai. 1970. Ecology of the Fort Reliance-Artillery Lake area. Can. Wildl. Serv., File Rep. 99 p.

Krajina, V.J. 1972. Ecosystem perspectives in forestry. The H.R. MacMillan Lectureships in Forestry, Univ. British Columbia. 31 p.

Pipeline Application Assessment Group. 1974. Mackenzie Valley pipeline assessment. Can. Dep. Indian North. Aff. Ottawa. 442 p.

Rutter, N.W., G.V. Minning and J. Netterville. 1972. Terrain maps, Mackenzie Valley (Mapsheets 85 E, 95 A, J, and H). Geol. Surv. Can., Open File No. 93.

Scotter, G.W., N.M. Simmons, H.L. Simmons, and S.C. Zoltai. 1971. Ecology of the South Nahanni and Flat River areas. Can. Wildl. Serv., File rep. 186 p.

Subcommittee on Biophysical Land Classification. 1969. Guidelines for Biophysical Land Classification (Comp. and ed. by D.S. Lacate). Can. For. Ser. Publ. No. 1264. 61 p.

Tarnocai, C. 1973. Soils of the Mackenzie River area. Environ. -Soc. Comm., North. Pipelines, Task Force North. Oil Dev., Rep. No. 73-26, 136 p.

Tarnocai, C. 1976. Soils of Bathurst, Cornwallis, and adjacent islands, District of Franklin, Geol. Surv. Can. Paper 76-1. Pt. B, 137-141.

Tarnocai, C. 1977. Soils of north-central Keewatin, Geol. Surv. Can., Paper 77-1. Pt. A, 61-64.

Tarnocai, C. and A.N. Boydell. 1975. Biophysical study of the Boothia Peninsula and Northern Keewatin. Geol. Surv. Can. Paper 75-1, Pt. A, 423-424.

Tarnocai, C., A.N. Boydell, J.A. Netterville, and K.A. Drabinsky. 1976. Biophysical land classification of the Boothia Peninsula and Northeast Keewatin, N.W.T. Geol. Surv. Can., Open File No. 390.

Tarnocai, C. and J.A. Netterville. 1976. Biophysical land classification in Boothia Peninsula and northeast Keewatin, N.W.T. pp. 159-171. *in:* Proc. 1st. Meeting Can. Comm. Ecol. Land Classif. (Comp. and ed. by J. Thie and G. Ironside). Ecol. Land Class. Ser. No. 1. Lands Directorate, Environment Canada. Ottawa.

Woo, V. and S.C. Zoltai. 1977. Reconnaissance of the soils and vegeattion of Somerset and Prince of Wales islands, N.W.T. Fish. Environ. Can., Ca. For. Serv., North. For. Res. Cent., Inf. Rep. NOR-X-186. 127 p.

Zoltai, S.C. 1977. Ecological Land classification in northern Canada. pp. 311-320 *in:* Proc. Sym. on Ecological Land Classification of Forest Land in Canada and Northwestern U.S.A. Vancouver, B.C. Sept. 1977.

Zoltai, S.C. and W.W. Pettapiece. 1973. Terrain, vegetation and permafrost relationships in the northern part of the Mackenzie Valley and northern Yukon. Environ.-Soc. Comm., North. Pipelines, Task Force North. Oil Dev., Rep. No. 73-2. 105 p.

Zoltai, S.C. and V. Woo. 1976. Soils and vegetation of Somerset and Prince of Wales islands, District of Franklin. Geol. Surv. Can., Paper 76, Pt. B, 143-145.

APPENDICES

AGENDA
CCELC SECOND MEETING
QUEEN VICTORIA INN
VICTORIA, B.C.

Monday April 3

21:00 - 24:00 Welcome/Bienvenue Reception

Tuesday April 4

08:00 - 09:00 Registration

09:00 - 12:00 Opening Session
Chairman: A.N. Boydell

(1) Outline of Meeting

(2) CCELC Chairman's Report - J. Thie

(3) Reports of Working Group Chairmen - S. Rowe, E. Wiken, N. Lopoukhine, F. Pollett

(4) Reports by Provincial Representatives - A.N. Boydell, A. Appleby, J. Prokopchuk, G. Mills, A. Boissonneau

(5) Discussion

13:30 - 16:30 CGIS Ecological Data Base Demonstrations for workshop groups - N. Chartrand

14:00 - 16:30 CCELC Workshops

(1) Methodology/Philosophy
Chairman: S. Rowe

(2) Land/Water Integration
Chairman: N. Lopoukhine

(3) Wetland Classification
Chairman: F. Pollett

(4) CCELC Organization and Priorities
Chairman: J. Thie

(5) Information Exchange
Chairman: P. Glaude

Tuesday April 4 (cont.)

19:30 - 20:00 Summarization of Afternoon Workshops by Rapporteurs

20:15 - 22:00 CCELC Workshops

(6) Ecoregions
Chairman: S. Zoltai

(7) Ecological Land Classification Guidelines (A)
Chairman: D. Welch

(8) Methodology/Philosophy
Chairman: S. Rowe

(9) CCELC Organization
Chairman: T. Boydell

(10) Vegetation
Chairman: V. Gerardin

(11) Ecological Land Classification Guidelines (B)
Chairman: P. Duffy

Wednesday April 5

08:30 - 12:00 Technical Workshop

(1) Introduction - J. Thie

(2) Parks Canada Applications of Biophysical Land Classification for Resources Management - K. East and K. Seel

(3) Use of Ecological Information in Settlement Planning - A. Quin

(4) The Applications of the James Bay Ecological Inventory: A Manager's Appreciation - P. Normandeau and P. Glaude

(5) Ecological Land Classifica-

Wednesday April 5 (cont.)

	tion Applications in Alberta - N. van Waas
13:00 - 14:15	(6) A Methodology for Environmental Impact Analysis in Predesign and Planning Studies - E. Macintosh
	(7) Environmental Information In a Planning/Management Context - R. Lang
14:30 - 17:00	Theme Workshops: Applications of Ecological Land Classification
	(1) Ecological Land Use Planning Chairman: K. East
	(2) Costs/Benefits of Ecological Land Classification Chairman: G. Mills
	(3) Guidelines for Ecological Interpretations Chairman: W. Holland
	(4) Information Presentation and Communication Chairman: D. Bates
19:30 - 20:00	Introduction to Field Trip - W. Bourgeois
20:00 - 21:30	Plenary Session
	(1) Summary of CCELC Workshops by Rapporteurs
	(2) Summary of Theme Workshops by Rapporteurs
	(3) Discussion

Thursday April 6

07:00 - 18:00	Field Trip - Tour arranged by B.C. Forest Products Ltd. and MacMillan Bloedel Ltd. of the Cowichan Valley Demonstration Forest and Franklin-Sarita Forest Divisions. Stops Include: Skutz Falls Cutoff, Cottonwood Creek, Cowichan Lake, Youbou, Flora Lake, Branch Road 209D, Klanawa West Fork, and Darling Main Trunk Road.
18:00 - 20:00	Banquet at Village Green Inn, Duncan, B.C.

Friday April 7

08:30 - 10:30	Business Session
	(1) Report of Ad Hoc Committee on Chairmanship for the CCELC - R. Fulton
	(2) Summary of Workshop Sessions - D. Welch, J. Thie, and E. Wiken
	(3) Summary of Working Group Recommendations
	(4) Discussion and Recommendations for future activities

ORDRE DU JOUR
DEUXIÈME RÉUNION DU CCCET
QUEEN VICTORIA INN
VICTORIA, C.B.

Le lundi 3 avril

21:00 - 24:00 Bienvenue, réception

Le mardi 4 avril

08:00 - 09:00 Inscription

09:00 - 12:00 Session d'ouverture
Président: A.N. Boydell

(1) Grandes lignes de la réunion

(2) Rapport du président du CCCET - J. Thie

(3) Rapports des présidents des groupes de travail - S. Rowe, N. Lopoukhine, F. Pollett et E. Wiken

(4) Rapports des représentants provincaux - A. Appleby, A. Boissonneau, A. Boydell, G. Mills, et J. Prokopchuk

(5) Délibérations

13:30 - 16:30 Présentations sur les bases de données écologiques de la SIGEC à l'intention des participants aux ateliers - N. Chartrand

14:00 - 16:30 Ateliers du CCCET

(1) Méthodologie/Philosophie
Président: S. Rowe

(2) Intégration Terres/Eau
Président: N. Lopoukhine

(3) Classification des Terres Humides
Président: F. Pollett

(4) Organisation et Ordre de Priorité du CCCET
Président: J. Thie

(5) Échange d'information
Président: P. Glaude

19:30 - 20:00 Présentation par les rapporteurs de résumés des ateliers tenus pendant l'après-midi

20:15 - 22:00 Ateliers du CCCET

(6) Ecorégions
Président: S. Zoltai

(7) Lignes Directrices de la Classification Ecologique des Terres (A)
President: D. Welch

(8) Méthologie/Philosophie
Président: S. Rowe

(9) Organisation du CCCET
Président: A. Boydell

(10) Végétation
Président: V. Gerardin

(11) Lignes Directrices de la Classification Écologique des Terres (B)
President: P. Duffy

Le mercredi 5 avril

08:30 - 12:00 Atelier Technique

(1) Introduction - J. Thie

(2) Applications de la classification biophysique des terres à la gestion des ressources par Parcs Canada - K. East et K. Seel

(3) Utilisations de l'information écologique aux fins de la planification des établissements humains - A. Quin

(4) Applications de l'inventaire écologique du territoire

de la baie James - une évaluation de gestionnaire - P. Normandeau et P. Glaude

(5) Applications de la classification écologique des terres en Alberta - N. van Waas

13:30 - 14:15 (6) Méthodologie d'analyse des incidences environnementales au cours des études de conception et de planification - E. Macintosh

(7) L'information environnementale dans le contexte de la planification et la gestion - R. Lang

14:30 - 17:00 Ateliers Thématiques: Les Applications de la Classification Écologique du Territoire

(1) Planification Écologique de l'Occupation des Terres
Président: K. East

(2) Coûts-Avantages de la Classification Écologique des Terres
Président: G. Mills

(3) Lignes Directrices des Interprétations Écologiques
Président: W. Holland

(4) Présentation et Communication de l'Information
Président: D. Bates

19:30 - 20:00 Introduction à l'excursion - W. Bourgeois

20:00 - 21:30 Session Plénière

(1) Présentation par les rapporteurs de sommaires des ateliers du CCCET

(2) Présentation par les rapporteurs de sommaires des ateliers thématiques

(3) Délibérations

<u>Le jeudi 6 avril</u>

07:00 - 18:00 Excursion - Organisée par les sociétés B.C. Forest Products Ltd. et MacMillan Bloedel Ltd., une visite à la forêt de démonstration de la vallée de la Cowichan ainsi que des divisions forestières Franklin et Sarita.

Les Haltes: Repli Skutz Falls; ruisseau Cottonwood; lac Cowichan; Youbou; lac Flora; chemin d'accès 209D; bras ouest de la Klanawa; et chemin principal Darling.

18:00 - 20:00 Banquet au Village Green Inn, à Duncan, C.B.

<u>Le vendredi 7 avril</u>

08:30 - 10:30 Session d'Affaires
Président: J. Thie

(1) Rapport du comité spécial sur la présidence du CCCET - - R. Fulton

(2) Sommaires des ateliers - D. Welch, J. Thie et E. Wiken

(3) Sommaire des recommandations des groupes de travail

(4) Délibérations et recommandations en vue d'activités futures

LIST OF PARTICIPANTS
LISTE DES PARTICIPANTS

Appleby, Alan G.
Land Use Division, Resources Branch
Department of Northern Saskatchewan
48 12th Street East,Room 200
Prince Albert, Sask.
S6V 1B2
Tel: (306) 764-6848

Barnett, Martin
Northern Environmental Protection and
Renewable Resources Branch
Department of Indian and Northern Affairs
Ottawa, Ontario
K1A OH4
Tel: (819) 997-9000

Bates, Dave
Ministry Natural Resources
Ontario Centre for Remote Sensing
880 Bay St., 3rd Floor
Toronto, Ontario
M5S 1Z8
Tel: (416) 965-8411

Boissonneau, Arthur
Ontario Centre for Remote Sensing
880 Bay St., 3rd Floor
Toronto Ontario
M5S 1Z8
Tel: (416) 965-8411

Bourgeois, Bill L.
MacMillan Bloedel Ltd.
65 Front Street
Nanaimo, B.C. V9R 5H9
Tel: (604) 753-1112

Boydell, A.N. (Tony)
Resource Analysis Branch
Min. of the Environment
Parliament Buildings
Victoria, B.C.
V8V 1X4
Tel: (604) 387-5619

Chamberlin, Tom W.
Resource Analysis Branch
839 Academy Close
Victoria, B.C.
V8V 1X4
Tel: (604) 387-5281

Chartrand, Nicole
Lands Directorate
Environment Canada
Ottawa, Ontario
K1A OE7
Tel: (819) 997-2510

Cowell, Daryl W.
Lands Directorate
Ontario Region
Box 5050
Burlington, Ontario
L7R 4A6
Tel: (416) 637-4323

Crosby-Diewold, Janice M.
Beak Consultants Ltd.
3530 11A St. N.E.
Calgary, Alberta
T2E 6M7
Tel: (403) 276-3357

Ducruc, Jean-Pierre
Service des Études Écologique Régionales
Direction Régionale des Terres
C.P. 10100
Ste-Foy, Québec
G1V 4C7
Tel: (418) 653-7340

Duffy, Pat. J.
Environmental Assessment Panel
Environment Canada
Ottawa, Ontario
K1A OH3
Tel: (613) 997-1000

East, Ken M.
Natural Resources Division
Parks Canada
Ottawa, Ontario
K1A OH4
Tel: (613) 995-8676

Edlund, Sylvia A.
Room 237
401 Lebreton Street
Terrain Sciences Division
Geological Survey of Canada
Ottawa, Ontario
K1A OE8
Tel: (613) 593-6099

Eedy, Wilson
Beak Consultants Ltd.
6870 Goreway Drive
Mississauga, Ontario
L4V 1L9
Tel: (416) 671-2600

Findlay, Bruce
Atmospheric Environment Service
4905 Dufferin St.
Downsview, Ontario
M3H 5T4
Tel: (416) 667-4625

Friend, Tony
Office of the Senior Advisor on Integration
Statistics Canada
Ottawa, Ontario
K1A 0T6
Tel: (613) 992-4571

Fulton, R.J. (Bob)
Geological Survey of Canada
601 Booth St.
Ottawa, Ontario
K1A 0G1
Tel: (613) 593-6094

Gagnon, Gilles
Ministère des Terres et Forêts
Complexe scientifique
2700 Rue Einstein
Ste-Foy, Québec
G1P 3W8
Tel: (418) 643-7606

Gerardin, Vincent
Direction Régionale des Terres
C.P. 10100
Ste-Foy, Québec
G1V 4C7
Tel: (418) 653-5345

Gimbarzevksy, Philip
Forest Management Institute
Environment Canada
396 Cooper St.
Ottawa, Ontario
K1G 3Z6
Tel: (613) 995-7010

Glaude, Pierre
Lands Directorate
Environment Canada
Ottawa, Ontario
K1A 0E7
Tel: (819) 997-2470

Harris, Wayne
Room 300, Provincial Office Bldg.
Forestry Branch
Department of Tourism and Renewable Resources
Prince Albert, Saskatchewan
S6V 1B5
Tel: (306) 763-6434

Hart, Bob T.
Wildlife Resources Branch
Department of Tourism and Renewable Resources
2602 8th St. East
Saskatoon, Saskatchewan
S7H 0V7
Tel: (306) 664-5769

Holland, Wil D.
Canadian Forestry Service
5320 - 122St.
Edmonton, Alberta
T6H 3S5
Tel: (403) 435-7232

Kenk, Evert
Resource Analysis Branch
1873 Spall Road
Kelowna, B.C.
V1Y 4R2
Tel: (604) 860-7393

Kerr, Anne
Lands Directorate
Pacific and Yukon Region
Room 904, 1001 West Pender St.
Vancouver, B.C.
V6E 2M7
Tel: (604) 666-8964

Kot, Ron J.
Resource Analysis Branch
Parliament Bldgs.
Victoria, B.C.
V8V 1X4
Tel: (604) 387-6995

Lamont, Sheila M.
Museum of Natural History
2445 Albert St.
Regina, Saskatchewan
S4S 0B3
Tel: (306) 565-2798

Lang, Reg
Faculty of Environmental Studies
York University
4700 Keele St.
Downsview, Ontario
M3J 2R2
Tel: (416) 667-6298

Levasseur, Jean-Marc
Société de Dévelopement de la Baie James
Suite 2200, 800 est blvd. de Maisonneuve
Montréal, Québec
H2L 4M6
Tel: (514) 284-0270

Lopoukhine, Nick
Lands Directorate
Atlantic Region
P.O. Box 365
Halifax, N.S.
B3A 2Y3
Tel: (902) 426-4196

Lord, Terry
Agriculture Canada
6660 N.W. Marine Drive
Vancouver, B.C.
V6T 1X2
Tel: (604) 224-4355

Luff, David
Resource Evaluation and Planning Division
Alberta Energy and Natural Resources
9945 - 108 St., 5th Floor
North Tower Petroleum Plaza
Edmonton, Alberta
T5K 2C9
Tel: (403) 427-3609

Luttmerding, Herb A.
B.C. Ministry of Environment
1873 Spall Road
Kelowna, B.C.
V1Y 4R2
Tel: (604) 860-7393

Mackintosh, Ernie E.
Department of Land Resource Science
University of Guelph
Guelph, Ontario
N1G 2W1
Tel: (519) 824-4120 Loc. 2486

Marcotte, Gilles
Ministère des terres et forêts
2700 rue Einstein
Ste-Foy, Québec
G1P 3W8
Tel: (418) 643-7606

McCullough, Greg
Freshwater Institute
Environment Canada
501 University Crescent
Winnipeg, Manitoba
R3T 2N6
Tel: (204) 269-7379

McQueen, Don
Acres Consulting Services Ltd.
9th Floor, 850 West Hastings St.
Vancouver, B.C.
V6C 1E1
Tel: (604) 683-9141

Mills, Gordon F.
Canada-Manitoba Soil Survey
Dept. of Soil Science
University of Manitoba
Winnipeg, Manitoba
R3T 2N2
Tel: (204) 474-8153

Moon, David E.
Agriculture Canada
6660 N.W. Marine Drive
Vancouver, B.C.
V6T 1X2
Tel: (604) 224-4355

Nikleva, Steve
Atmospheric Environment Serivce
739 West Hastings St.
Vancouver, B.C.
V6C 1A1
Tel: (604) 666-1903

Normandeau, Pierre
Société de Dévelopement de la Baie James
800 est blvd. de Maisonneuve
Suite 2200,
Montréal,Québec
H2L 4M6
Tel: (514) 284-0270

Padbury, Glenn
Soil Science Dept.
University of Saskatchewan
Saskatoon, Saskatchewan
S7N 0W0
Tel: (306) 665-4015

Pollett, Fred C.
Newfoundland Forest Research Centre
Canadian Forestry Service
St. John's, Newfoundland
A1C 5X8
Tel: (709) 737-4682

Poulin, Marg
CCELC Secretariat
Lands Directorate
Environment Canada
Ottawa, Ontario
K1A 0E7
Tel: (819) 997-2320

Prokopchuk, Jary R.
Resource Inventory and Appraisal Branch
Alberta Energy and Natural Resource
3rd Floor, Petroleum Plaza - North Tower
Edmonton, Alberta
T5K 2C9
Tel: (403) 427-7474

Quin, Tony
Planning Services
B.C. Ministry of Municipal Affairs and Housing
Victoria, B.C.
V8V 1X4
Tel: (604) 387-5925

Rennick, Paul H.
Acres Consulting Services
5259 Dorchester Road
Niagara Falls, Ontario
L2E 6W1
Tel: (416) 354-3831

Rostad, Harold
Sask. Institute of Pedology
University of Saskatchewan
Saskatoon, Saskatchewan
S7N OWO
Tel: (306) 665-4017

Rowe, J. Stan
Department of Plant Ecology
University of Saskatchewan
Saskatoon, Saskatchewan
S7N OWO
Tel: (306) 343-3186

Rubec, Clay
Lands Directorate
Environment Canada
Ottawa, Ontario
K1A OE7
Tel: (819) 997- 2320

Schreier, H.
Dept. of Soil Science
Univ. of British Columbia
Vancouver, B.C.
V6T 1X2
Tel: (604) 228-3477

Seel, Kurt E.
Western Regional Office
Parks Canada
134 - 11th Ave. S.E.
Calgary, Alberta
T2G OX5
Tel: (403) 231-4459

Senyk, John P.
Canadian Forestry Service
506 W. Burnside Road
Victoria, B.C.
V8Z 1M5
Tel: (604) 388-3811

Slavinski, Howard C.
Agriculture Canada
6660 N.W. Marine Drive
Vancouver, B.C.
V6T 1X2
Tel: (604) 224-4355

Tarnocai, Charles
Soils Coordinator, Central Region
Land Resource Research Institute
Room 3022, Neatby Bldg.
Agriculture Canada
Ottawa, Ontario K1A OC6
Tel: (613) 994-9657

Thie, Jean
Lands Directorate
Environment Canada
Ottawa, Ontario
K1A OE7
Tel: (819) 997-2320

Travers, O. Ray
Resource Analysis Branch
Ministry of the Environment
Victoria, B.C.
V8V 1X4
Tel: (604) 387-6995

van Barneveld, Jim W.
1873 Spall Road, Reource Analysis Branch
Kelowna, B.C.
V1Y 4R2
Tel: (604) 860-7393

van Vliet, Lawrence
Agriculture Canada
6660 N.W. Marine Drive
Vancouver, B.C.
V6T 1X2
Tel: (604) 224-4355

van Waas, C. Neil
Resource Evaluation and Planning Division
Resource Appraisal Group
Petroleum Plaza North Tower
9945- 108th St., Third Floor
Edmonton, Alberta
T5K 2C9
Tel: (403) 427-3411

Vold, Terje
Ministry of the Environment
Resource Analysis Branch
Victoria, B.C.
V8V 1X4
Tel: (604) 387-5281

Welch, David
Lands Directorate
Environment Canada
Ottawa, Ontario
K1A OE7
Tel: (819) 997-2320

Wickware, Greg M.
Lands Directorate
Ontario Region
Box 5050
Burlington, Ontario
L7R 4A6
Tel: (416) 637-4552

Wiken, Ed
Lands Directorate
Environment Canada
Ottawa, Ontario
K1A 0E7
Tel: (819) 997-2320

Zoltai, Steve C.
Canadian Forestry Service
Northern Forest Research Centre
5320 - 122nd St.
Edmonton, Alberta
T6H 3S5
Tel: (403) 635-7210

ECOLOGICAL LAND CLASSIFICATION SERIES

* No. 0. Canada Committee on Ecological (Biophysical) Land Classification. 1979. Canada's Northlands (Second Edition). Proc. of a Technical Workshop — To develop an integrated approach to base data surveys for Canada's Northlands, 17-19 April 1974, Toronto, Ont. Comp. and ed. by M.J. Romaine and G.R. Ironside. 124p. Cat. No.: EN 73-3/0. Free.

* No. 1. Canada Committee on Ecological (Biophysical) Land Classification. 1977. Ecological (Biophysical) Land Classification in Canada: Proc. First Meeting Can. Comm. on Ecol. (Biophys.) Land Classif., 25-28 May 1976, Petawawa, Ont. Ed. by J. Thie and G. Ironside. 269p. Includes abstracts and some text in French. Cat. No.: EN73-3/1. ISBN: 0-662-00473-6. Free.

** No. 2. Jurdant, M., J.L. Bélair, V. Gerardin, and J.P. Ducruc. 1977. L'inventaire du Capital-Nature: Méthode de classification et de cartographie écologique du territoire. (English text in preparation). Cat. No.: EN 73-3/2F. ISBN: 0-660-00755-X. Price $7.00 (Canada); $8.40 (other countries)

** No. 3. Canada Committee on Ecologial (Bio-Physical) Land Classification. 1977. Ecological (Biophysical) Land Classification in Urban Areas: Proc. of a workshop, 23-24 November 1976, Toronto, Ont. Comp. and ed. by E.B. Wiken and G.R. Ironside. 167p. Includes abstracts and some text in French. Cat. No.: EN 73-3/3. ISBN:0-660-01415-7. Price $4.00 (Canada); $4.80 (other countries).

*** No. 4. Lopoukhine, N., N.A. Prout, and H.E. Hirvonen. 1978. The Ecological Land Classification of Labrador; A Reconnaissance. 85p. and map. Cat. No.: EN 73-3/4.

** No. 5. Welch, D.M. 1978. Land/Water Classification: A review of water classifications and proposals for water integration into ecological land classification. 54p. Cat. No.: EN 73-3/5. ISBN: 0-660-10039-8. Price: $4.50 (Canada); $5.40 (other countries).

SÉRIE DE LA CLASSIFICATION ÉCOLOGIQUE DU TERRITOIRE

* N° 0. Comité Canadien de la Classification Écologique du Territoire. 1979. Canada's Northlands (Second Edition). Proc. of a Technical Workshop — To develop an integrated approach to base data surveys for Canada's Northlands, 17-19 avril 1974, Toronto, Ont. Comp. et éd. par M.J. Romaine et G.R. Ironside. 124p. N° de Cat.: EN 73-3/0. Gratuit.

* N° 1. Comité Canadien de la Classification Écologique du Territoire. 1977. Classification Écologique (Biophysique) du Territoire au Canada: Compte rendu de la première réunion du Com. Can. de la Classif. Ecol. du Terr., 25-28 mai 1976, Petawawa, Ont. Éd. par J. Thie et G. Ironside. 269p. Comprend des résumés et des textes en français. N° de Cat.: EN 73-3/1. IBSN: 0-662-00473-6. Gratuit.

** N° 2. Jurdant, M., J.L. Bélair, V. Gerardin, et J.P. Ducruc. 1977. L'inventaire du Capital-Nature: Méthode de classification et de cartographie écologique du territoire. Texte en français. 202p. N° de Cat.: EN 73-3/2F. ISBN: 0-660-00755-X. Prix $7.00 (Canada); $8.40 (autres pays).

** N° 3. Comité Canadien de la Classification Écologique du Territoire. 1977. Classification Écologique (Biophysique) du Territoire dans les Régions Urbaines: Compte rendu d'un atelier, 23-24 novembre 1976, Toronto, Ontario. Comp. et éd. par E.B. Wiken et G.R. Ironside. 167p. Comprend des résumés et des textes en français. N° de Cat.: EN 73-3/3. ISBN: 0-660-01415-7. Prix $4.00 (Canada); $4.80 (autres pays).

*** N° 4. Lopoukhine, N., N.A. Prout, et H.E. Hirvonen. 1978. The Ecological Land Classification of Labrador; A reconnaissance. 85p. et carte. N° de Cat.: EN 73-3/4.

** N° 5. Welch, D.M. 1978. Land/Water Classification: A review of water classifications and proposals for water integration into ecological land classification. 54p. N° de Cat.: EN 73-3/5. ISBN: 0-660-10039-8. Prix: $4.50 (Canada); $5.40 (autres pays).

No. 6. Wiken, E.B. Ecological (Biophysical) Land Classification: An Analysis of Methodologies. To be published at a later date. Cat. No.: EN 73-3/6.

No. 7. Canada Committee on Ecological (Biophysical) Land Classification. 1979. Applications of Ecological (Biophysical) Land Classification in Canada: Proc. Second Meeting Can. Comm. on Ecol. (Biophys.) Land Classif., 4-7 April 1978, Victoria, B.C. Comp. and ed. by C.D.A. Rubec. 396 p. Includes abstracts and some text in French. Cat. No.: EN 73-3/7.

The Ecological Land Classification Series is published by the Lands Directorate, Environment Canada.

N° 6. Wiken, E.B. Ecological (Biophysical) Land Classification: An Analysis of Methodologies. A être publier plus tard. N° de Cat.: EN 73-3/6.

N° 7. Comité Canadien de la Classification Écologique du Territoire. 1979. Applications de la Classification Écologique (Biophysique) du Territoire au Canada: Compte rendu de la deuxième réunion du Com. Can. de la Classif. Écol. du Terr., le 4-7 avril 1978, Victoria, C.B. 396 p. Comprend des résumés et des textes en français. N° de Cat.: EN 73-3/7.

La Série de la Classification Écologique du Territoire est publiée par la Direction générale des Terres, Environnement Canada.

---

* May be requested from:
Lands Directorate Information Officer
EMS Information Team
Environment Canada
11th Floor, Place Vincent Massey
Ottawa, Ontario
K1A OE7

** Available by mail from:
Printing and Publishing
Supply and Services Canada
Ottawa, Ontario
K1A OS9

*** May be requested from:
Lands Directorate
Atlantic Region
P.O. Box 365
Halifax, N.S.
B3J 2P8

Numbers 1 and 3 are also available in microfiche, free of charge, and may be requested from:
Lands Directorate
Environment Canada
20th Floor, Place Vincent Massey
Ottawa, Ontario
K1A OE7

* Il peut être obtenu en écrivant à:
Agent d'information de la Direction générale des Terres
Équipe d'information SGE
Environnement Canada
11ième étage, Place Vincent Massey
Ottawa, Ontario.
K1A OE7.

** En vente par la poste:
Imprimerie et Édition
Approvisionnements et Services Canada
Ottawa, Ontario
K1A OS9

*** Il peut être obtenu en écrivant à:
Direction régionale des Terres
Région de l'Atlantique
C.P. 365
Halifax, Nouvelle-Écosse.
B3J 2P8

Les numéros 1 et 3 sont aussi disponibles en microfiche (gratuits) et peuvent être obtenus en écrivant à:
Direction générale des Terres
Environnement Canada
20ième étage, Place Vincent Massey
Ottawa, Ontario
K1A OE7

Environment Canada
Environnement Canada

Lands Directorate
Direction générale des terres